Chapter 2. Background: A Description of the Species, the Fishery, and Social and Economic Components of the Market Squid Fishery

2.1 Species Description

Squid (also referred to as Cephalopods) belong to the class Cephalopoda of the phylum Mollusca. There are approximately 750 recognized species of squids alive today and more than 10,000 fossil forms of cephalopods. Squid have large, well-developed eyes and strong parrot-like beaks. They use their fins for swimming in much the same way fish do and their funnel for extremely rapid "jet" propulsion forward or backward. The squid's capacity for sustained swimming allows it to migrate long distances as well as to move vertically through hundreds of meters of water during daily foraging (feeding) bouts.

The common name for *Loligo opalescens* Berry, 1911 is market squid or opalescent squid. At a recent international cephalopod meeting (February 2003), the consensus was that, based on morphology and molecular evidence, the scientific name for market squid should be changed to *Doryteuthis (Amerigo) opalescens* (F. G. Hochberg, pers. comm.). This has not been formalized nor published. Current authority for the squid fishery [Fish and Game Code (FGC) §8420] refers to *L. opalescens* as “market squid” and this common name is used throughout the Market Squid Fishery Management Plan (MSFMP) (FGC §8045).

Market squid belong to the family Loliginidae. These squid generally have a mixed, iridescent (opalescent) coloration of milky white and purple; however, color changes occur rapidly in response to environmental conditions. Similar to most squid species, market squid possess an ink sac, which serves as a defense mechanism by expelling ink to confound predators. Market squid are less than 3 mm at hatching and grow to an average mantle length of 152 mm at the time of spawning. Squid have eight arms and two longer feeding tentacles. Males are larger and more robust than females. Market squid are terminal spawners, spawning occurs at the end of their lifespan. In California, commercial fisheries target adults during spawning events. Recent age studies indicate that squid are a semi-annual species; the average age of squid taken in the fishery is six months (range 4-10 months, Butler et al. 2001).

2.1.1 Distribution, Stock Biomass, Genetic Stock Structure and Migration

The range of market squid is from the southern tip of Baja California, Mexico (23° N latitude) to southeastern Alaska (55° N latitude). Juveniles and adults range throughout the California and Alaska Current systems (Roper and Sweeney 1984). Paralarvae, the life stage of market squid at the time of hatching, are often collected in the waters closer to the shoreline (Zeidberg and Hamner 2002). Their distribution is patchy, yet if squid are found at one site, it is likely that additional squid will be found in close proximity (contagious distribution).

The California fleet currently fishes only adult squid during spawning events in limited geographic areas. The abundance of market squid at these known fishing areas is dramatically affected by environmental conditions, especially during El Niño events (when landings are minimal).

An El Niño event occurs when the sea surface temperatures in the eastern equatorial Pacific region along the coasts of Peru and Ecuador increase significantly above the average temperature for three or more months. A La Niña is characterized by unusually cold ocean temperatures in the equatorial Pacific. Currently, El Niños have a return period of four to five years. An El Niño Southern Oscillation (ENSO) describes the full range of the Southern Oscillation that includes both warming and cooling of sea surface temperatures when compared to a long-term average. The ENSO has two parts: the El Niño is the oceanic component and the Southern Oscillation is the atmospheric component of the phenomenon.

Little is known about the present size, age structure, or status of the market squid population. At present, no direct, statistically valid population estimates are available.

Genetic analyses have not been successful in distinguishing separate stocks within the California fishery. Both Gilly (2003) and Reichow and Smith (2001) concluded that spawning populations that are commercially harvested from the Channel Islands are not genetically distinguishable from those landed in Monterey Bay. Although Gilly et al. (2001) found slight but significant genetic distances between samples taken from central California and southern California, no temporal or spatial genetic differences for market squid within the Southern California Bight and no temporal differences between samples in the Monterey areas were evident. Presently, additional genetic research is now focusing on genetic differences at the extremes of the market squid range (Alaska and Baja California). Thus, the number of different stocks or subpopulations of market squid along the entire Pacific Coast is unknown at this time.

Market squid paralarvae are dispersed off egg bed areas by ocean currents and are found most commonly inshore, concentrated in areas where water masses converge (Okutani and McGowen 1969, Zeidberg and Hamner 2002). Although they are often widely distributed, the migration patterns of juveniles and prespawning adults are unknown. Midwater trawl surveys in 1999 collected juvenile market squid at 45% of the stations throughout the Southern California Bight (CDFG, unpublished data). Adult market squid migrate from pelagic waters to nearshore areas and form dense aggregations for spawning. Their vertical distribution during daylight hours ranges from 100 to 600 meters. At night, adults are located within the upper 100 m of the water column (Zeidberg and Hamner 2002).

2.1.2 Age and Growth

Market squid egg hatching rate is determined by temperature, with incubation time ranging from 22 to 90 days at temperatures from 42-68°F (Isaac et al. 2001). Squid eggs are commonly deposited in areas with water temperatures between 50-58°F resulting in incubation periods lasting from 34 to 52 days.

The age of market squid was determined using statoliths, balance structures analogous to otoliths in fish. Rings are deposited daily on statoliths and used to determine the life span of these invertebrates. Daily ring deposition has been validated for several squid species including *L. opalescens* and other members of the family Loliginidae and has been shown to be an accurate method for ageing squid (Jackson and Domeier 2003; Hurley et al. 1985; Lipinski 1986; Jackson 1990a, b, 1994, 1998; Bettencourt et al. 1996; Spratt 1978).

Butler et al. (2001) found that market squid growth increases with age and is best described with a power function:

$$\text{DML (mm)} = 0.001342 * \text{Age}^{2.132}$$

where DML is dorsal mantle length in millimeters and age is in days ($r^2 = 0.95$, $df = 275$, $P < 0.001$). Paralarvae growth is slow [0.05 mm DML/day] during the first month, but growth rates increase dramatically as squid mature.

The market squid fishery in California targets spawning squid that are believed to die shortly after spawning, thus, samples collected directly from fishing vessels are assumed to represent squid at or very near the end of their life span. From port samples collected from November 1998 through July 2000, 908 statoliths were aged (Figure 2-1). The mean age of harvested market squid was 188 days. The average male (190 days) was slightly older than average female (186 days); however, the range for females (108 - 302 days) was broader than males (114 – 281 days).

The age data exhibit little variation between months. This strongly suggests that a new cohort, a group of squid spawned during a certain period, enters the fishery almost monthly. Further, ageing techniques indicate that the average market squid lives approximately six months, but may be sexually mature as early as 3.6 months (108 days) and can spawn as late as 10 months (302 days). Less than 1 percent (4/908 or 0.4%) of the squid aged could not be sexed, demonstrating that sexually immature squid are rare among spawning or harvested squid.

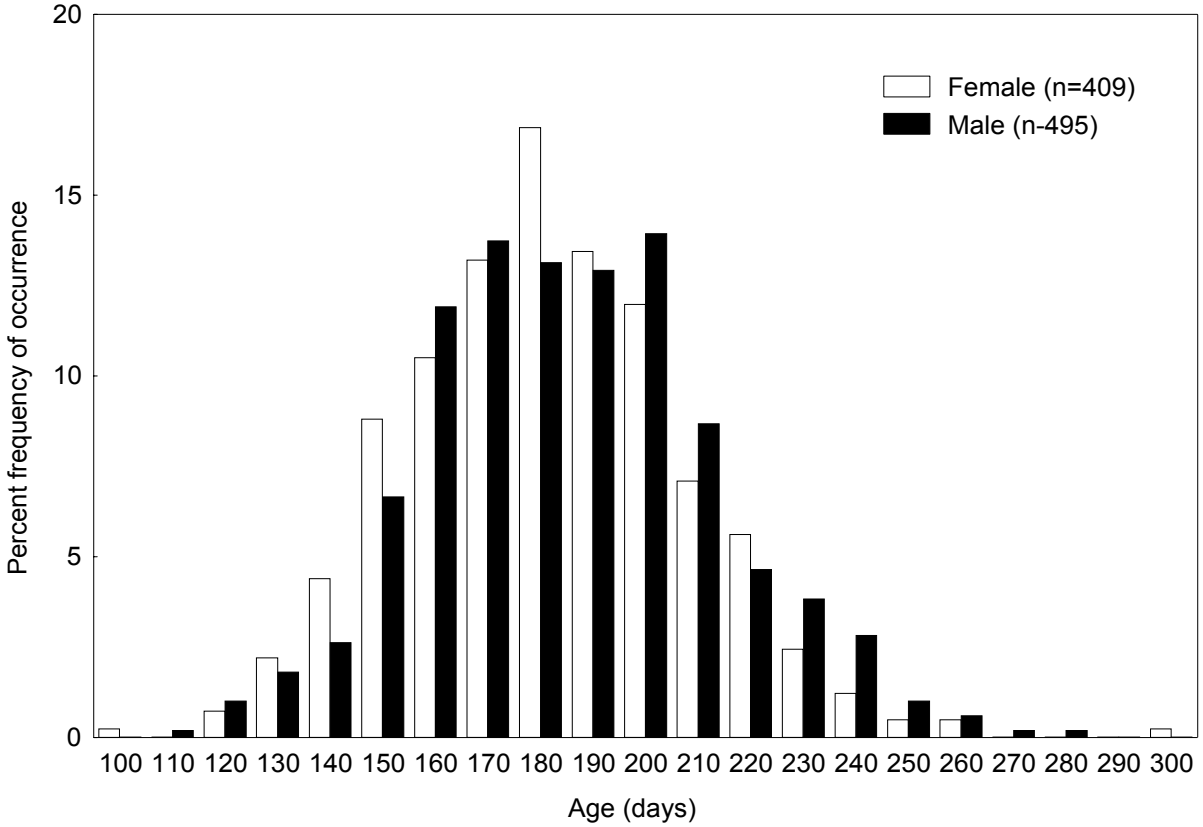

Figure 2-1. Number of market squid by age from port samples by sex. Source: CDFG Landing Receipts.

2.1.3 Reproduction, Seasonality and Fecundity

Spawning market squid tend to congregate in dense schools, usually over sandy habitats where they deposit extensive egg masses. In central California spawning activity starts around April and ends in October, while in southern California spawning events begin around October and end in April or May. The seasonality in spawning between central and southern California is attributable to ocean bottom temperatures rather than any biological difference. During some years, reproductive activity and landings may occur throughout most of the year. Year-round spawning in several areas statewide at different times of the year likely reduces the effects of poor local conditions on survival of eggs or hatchlings and indicates that stock abundance is not solely dependent on availability of squid from a single spawning area.

Mating takes place on spawning grounds but may also occur before squid move to their spawning sites. Male squid place spermatophores into the mantle cavity of females and eggs are fertilized as they are extruded (Hurley 1977). Off California, a female squid produces approximately 20 egg capsules (egg cases), with each capsule containing about 200 individual eggs that are suspended in a gelatinous matrix. The number of egg cases deposited and the number of eggs within egg cases vary by locale (numbers are reduced in Oregon). Further, the number of eggs within a capsule decline

throughout spawning. Females attach each egg capsule individually to the bottom substrate. As spawning continues, mounds of egg capsules covering more than 100 square meters may be formed and appear to carpet the sandy substrate. Market squid have been reported to die after completing their first and only spawning period (McGowan 1954, Fields 1965), but the duration of the spawning period is unknown. Recently, Hanlon et al. (2004) observed that females can spawn multiple times within a spawning period and do not die immediately after a single spawning event. In Monterey, spawning has been observed during daylight hours (Forsythe et al, 2004) as well as during the night (CDFG, unpublished data).

The lifetime fecundity of market squid is a critical life history trait; fecundity must be known to estimate the biomass using either egg deposition or larval production methods (Hunter and Lo 1997). Macewicz et al. (2001b, 2003) found that squid have a fixed reproductive output and die before developing and spawning all possible eggs in their ovaries. For an average female with a dorsal mantle length of 129mm, the potential fecundity is 3,844 eggs which increases with increasing length (Potential fecundity = 29.8 * dorsal mantle length (Macewicz et al. 2003).

2.1.4 Natural Mortality

Squid appear to exhibit a very high natural mortality rate and the adult population is composed of almost entirely new recruits. No spawner-recruit relationship has been demonstrated. These observations suggest that the entire stock is replaced annually, even in the absence of fishing. Thus, the stock is entirely dependent on successful spawning that occurs throughout each year coupled with good survival of recruits to adulthood.

Total mortality (natural and fishing) has been estimated to range from 0.3 to 0.6 per month (Maxwell 2001) based on squid ageing data (squid from six to 10 months) (Butler, et al. 2001). Full recruitment of market squid into the fishery occurs at six months. Additional studies on market squid mortality are needed.

2.1.5 Disease

Several marine worms utilize the squid as a host species; larval nematodes (roundworms), cestodes (tapeworms) and polychaetes (bristleworms) all have been recovered from squid and/or squid eggs. Nematodes, cestodes, and their larval stages have been found in market squid (Benjamins 2000). In Monterey Bay, Riser (1949) cited infestation of squid by two types of plerocercoid larvae. These larvae are tetraphyllidean cestodes that infest the large intestine of the squid. At Point Mugu, squid sampled from a commercial seafood outlet exhibited infestation by larval cestodes (orders Tetraphyllidea and Pseudophyllidea) and nematodes. These parasites were found to infect the eye, stomach, intestines, body cavity and tissues at a rate of 76.9% (Dailey 1969). The polychaete worm *Capitella ovincola* is a predator of market squid eggs. This worm has been found inside squid egg capsules (MacGinite and MacGinite 1949) but does not appear to affect squid fitness either by decreasing the egg hatching rate or triggering premature hatching (Morris et al. 1980).

2.1.6 Predator/Prey Relationships

2.1.6.1 Squid as Predators

Market squid feed on a variety of prey during their life cycle. As larvae and juveniles, squid consume copepods and euphasiids. These fast-moving prey items are a challenge to young squid; they enhance the development of prey-capture and escape skills (Preuss and Gilly 2000). As adults, market squid feed on fish, polychaete worms, squid (cannibalism),and crustaceans such as shrimp and pelagic red crab. Also, squid are found in commercial catches of anchovies, sardines, herring, mackerel, and sauries where they feed with and most likely upon these fish (Fields 1965). In Monterey Bay, larger squid have been found to feed chiefly on fish and cephalopods; however, there are significant differences in prey intake between depth and location rather than size classes (Karpov and Cailliet 1979).

Prey composition fluctuates with squid age, size, and reproductive status, as well as, spatially. The availability of prey and the behavior of market squid at different depths and locations may influence feeding behavior. Karpov and Cailliet (1978, 1979) found that crustaceans and cephalopod fragments were ingested at higher frequencies on spawning grounds than on non-spawning grounds. Inshore versus offshore samples of squid indicated differences in diet composition. In deeper waters, euphasiids and copepods were dominant prey items, while true cannibalism (intake of whole cephalopods) and fish consumption dominated in shallow waters.

2.1.6.2 Squid as Forage

Market squid are an integral part of the food web to many marine vertebrates. Fish, seabirds, and marine mammals all utilize squid as a prey item. Squid has been documented as an important dietary component of the sea otter, northern elephant seal, northern fur seal, California sea lion (Lowry and Carretta 1999), Dall's porpoise, Pacific striped dolphin, Risso's dolphin, toothed whales such as the short-finned pilot whale (Hacker 1992), the sperm whale, and the bottlenose whale (Fields 1965). In addition, seabirds such as the common murre, ashy storm-petrel, black storm-petrel, fork-tailed storm-petrel, and rhinoceros auklets feed on market squid (Morejohn et al. 1978). In Monterey Bay, 19 species of fish were found to feed upon market squid, including many commercially important species such as Pacific bonito, salmon, halibut, and tuna (Fields 1965, Morejohn et al. 1978) (Figure 2-2). These fishes include all depleted, threatened, and endangered salmon stocks along the coast. In fact predators from many trophic levels utilize both small pelagic fishes, such as northern anchovy and sardine, and squid as either a primary or supplementary food source (Table 2-1).

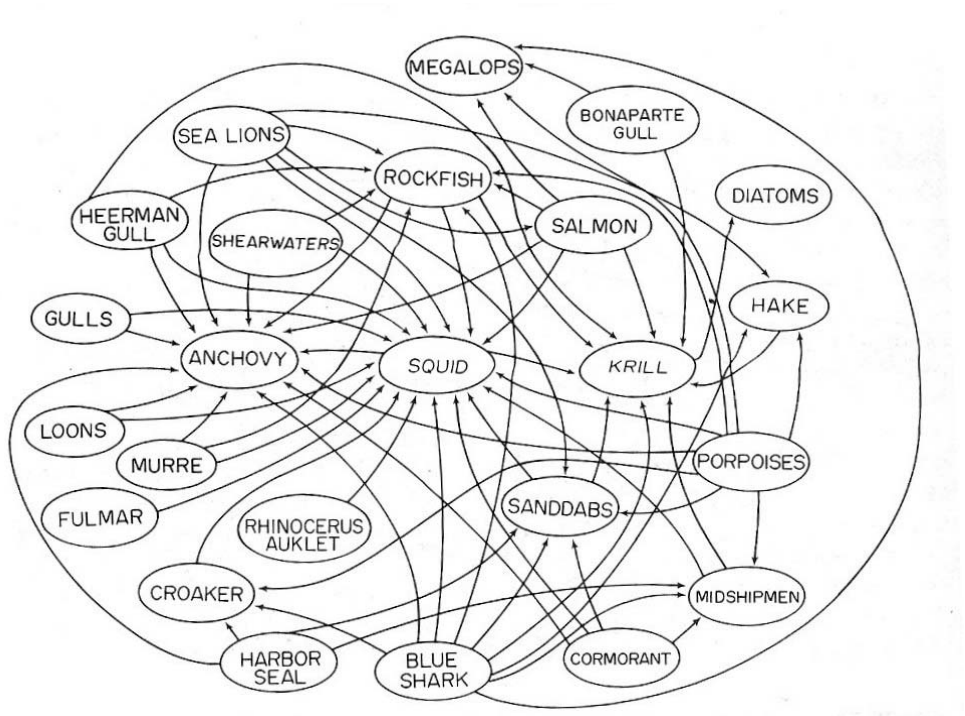

Figure 2-2. Food web for market squid, *Loligo opalescens*, involving commercially important or abundant fish, birds, and marine mammals (from Morejohn, et al. 1978).

Understanding how an ecosystem functions requires information on the trophic relationships of key species, including squid (May et al. 1979, Sydeman et al. 1997, Furness and Tasker 2000). Under MLMA, the Department must consider ecosystem impacts of a fishery, namely the conservation of not only the exploited species, but the other species that depend on that resource. In order to assess these fishery impacts on other species that also compete for that resource it is necessary to know how much that competitor depends on that resource. In fisheries which target lower trophic levels, such as market squid or sardines, natural predators are often thought of as competitors for the fishery resource (May et al. 1979, Dayton et al. 2002). At present, we do not have a complete understanding of the dynamics of many of these trophic relationships for squid; therefore, as additional research becomes available it will be incorporated into the MSFMP to better manage this fishery.

The proportion of the diet that squid makes up varies dramatically between species, geographical location, and environmental conditions. Most squid predators are not squid specialists, i.e., squid is rarely the sole prey item; because of its highly variable abundance, squid cannot be relied on as a stable food source, additionally, it has limited energetic value (O'Dor and Webber 1986). Therefore, squid predators often must switch to more abundant or energetically profitable prey species (Ainley et al. 1996, Sydeman et al. 1997), or target squid when they are most abundant during spawning aggregations and minimal energy is needed for capture.

For seabirds such as the common murre, squid composes 6-20% of the diet (by weight) depending on season, and is usually ranked 3rd or 4th after northern anchovy, Pacific

herring, and shiner surfperch (Ainley, et al. 1996). In terms of frequency-of-occurrence, the presence of squid varies dramatically. For diving birds such as rhinocerous auklets, common murres, artic loons, and Brandt's cormorants, the frequency-of-occurrence of squid in the diet can range from 33-85% (Baltz and Morejohn 1977). For plunging, surface feeding birds, such as shearwaters and gulls, the frequency-of-occurrence ranges from 0-67% (Baltz and Morejohn 1977).

Market squid are important as forage to a long list of fish and they serve as an important food source for many larger pelagic fish that are commercially and recreationally important, such as white seabass, yellowtail, kelp bass, barred sand bass, California barracuda, California halibut, and other nearshore species. For chinook salmon, squid composed 7-9% of diet (by volume) and ranked 3rd or 4th behind northern anchovy, euphausids, and juvenile rockfish depending on location, Monterey or San Francisco, respectively (Morejohn et al. 1978). At other locations along the west coast, squid is not an important prey item for chinook since they prey mainly on fish (Groot and Margolis 1991). In chilipepper rockfish, squid ranked 3rd behind juvenile rockfish and other fishes (Morejohn et al. 1978). Other fish predators in which squid ranked high as a prey item includes mainly bottom dwelling species including curlfin turbot, speckled and Pacific sanddabs, lingcod, petrale sole, and Pacific halibut (Morejohn et al. 1978). Several pelagic species also feed on squid when available such as blue shark, common thresher shark, and albacore (Morejohn et al. 1978).

For the California sea lion, squid occurs in 35-44% of scat samples collected at rookery sites in the Southern California Bight which can represent volumes as high as 27% of the diet by weight in non El Niño years and 16% in El Niño years (Lowry and Carretta 1999). In terms of prey rank, squid was either the primary or secondary prey item after northern anchovy, depending on location and environmental conditions. During an El Niño event, the presence of market squid in California sea lion and Pacific harbor seal scat samples decreased more than three-fold as compared to non El Niño periods (Henry 1997, Lowry and Carretta 1999).

Consumption estimates are known for some squid predators, although these can vary dramatically because squid availability changes with location and environmental conditions. For example, sea lions in southern California have been estimated to consume 68,000 tons of squid in non El Niño years and 30,000 tons in El Niño years (STAR Panel Working Paper #4, Appendix E). Dr. William Gilly estimated that three species, California sea lion, Dall's porpoise, and Risso's dolphin combined consume 125,000 tons of squid annually (pers. comm.). The changing availability of squid also affects potential predators. Short-finned pilot whales, blue sharks, and Pacific bonito increase their consumption of market squid during the squid spawning season. It has been suggested that short-finned pilot whales in the Southern California Bight (Hacker 1992, Miller et al. 1983, Dohl et al. 1980) and blue sharks near Santa Catalina Island (Tricas 1979) may move inshore as the squid spawning season begins. Pacific bonito consumption of squid is influenced by the shoaling behavior of squid spawning in nearshore waters of southern California (Oliphant 1971).

Seasonal landings of market squid in southern California ports have been strongly correlated with percent frequency-of-occurrence in sea lion diets (Figure 2-3). In El Niño years, resource availability is low for all species. In non El Niño years, squid appears to be serving as adequate forage for sea lions, even with high levels of fishing activities, as sea lion pup production or population trends do not appear to be affected. As a result of the 1998 El Niño, sea lion pup production at the Channel Islands declined 64% (Carretta et al. 2002). However in 1999, pup production increased by 185% resulting in the highest net productivity rate observed in sea lions for the past 20 years (Carretta et al. 2002). During that same period, commercial squid landings in California were the highest on record (126,772 tons) with over 99% of those landings coming from southern California. In recent years, concurrent with squid landings in excess of 100,000 tons annually, the sea lion population in California continues to increase at a rate of 5.4-6.1% per year (Carretta et al. in prep).

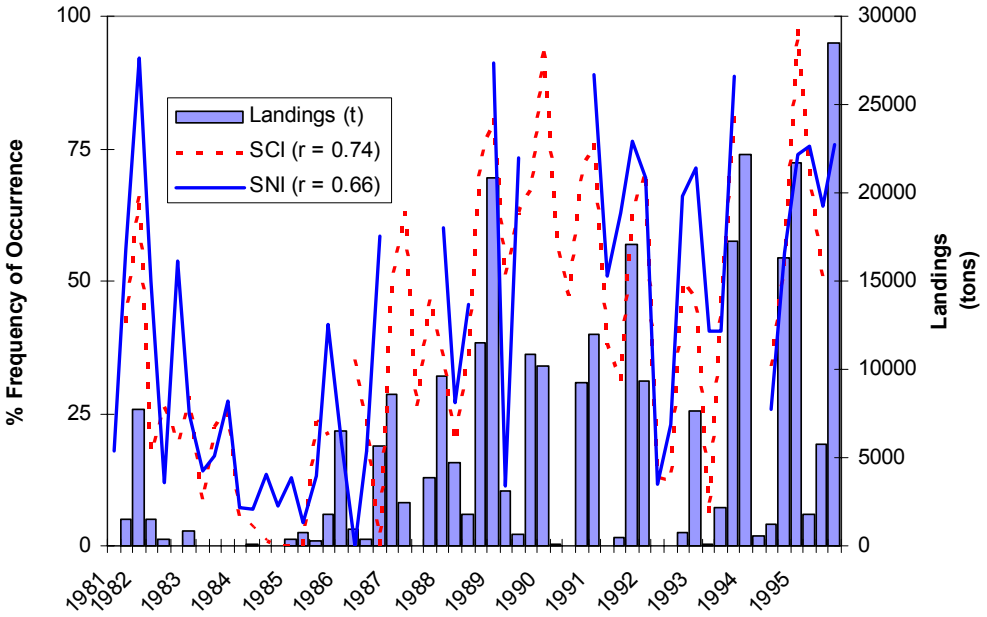

Figure 2-3. Seasonal Comparison of Sea Lion Scat Squid Frequency-of-Occurrence at San Clemente (SCI) and San Nicholas Islands (SNI) vs Squid landings in Southern California Ports (from Lowry and Carretta 1999).

Fishery independent data suggest that squid distribution is widespread, fishing does not occur in all areas of distribution, and not all spawning grounds are targeted. Historical evidence from research cruises along the west coast, as well as recent catch data, suggests that squid biomass may be very large at times and distributed widely along the entire west coast (Groundfish Triennial Bottom Trawl Survey, Midwater trawl surveys, Kenny Mais survey, etc., STAR Panel Working Paper #5), suggesting that a large portion of the squid biomass is available to other trophic levels (Figure 2-4).

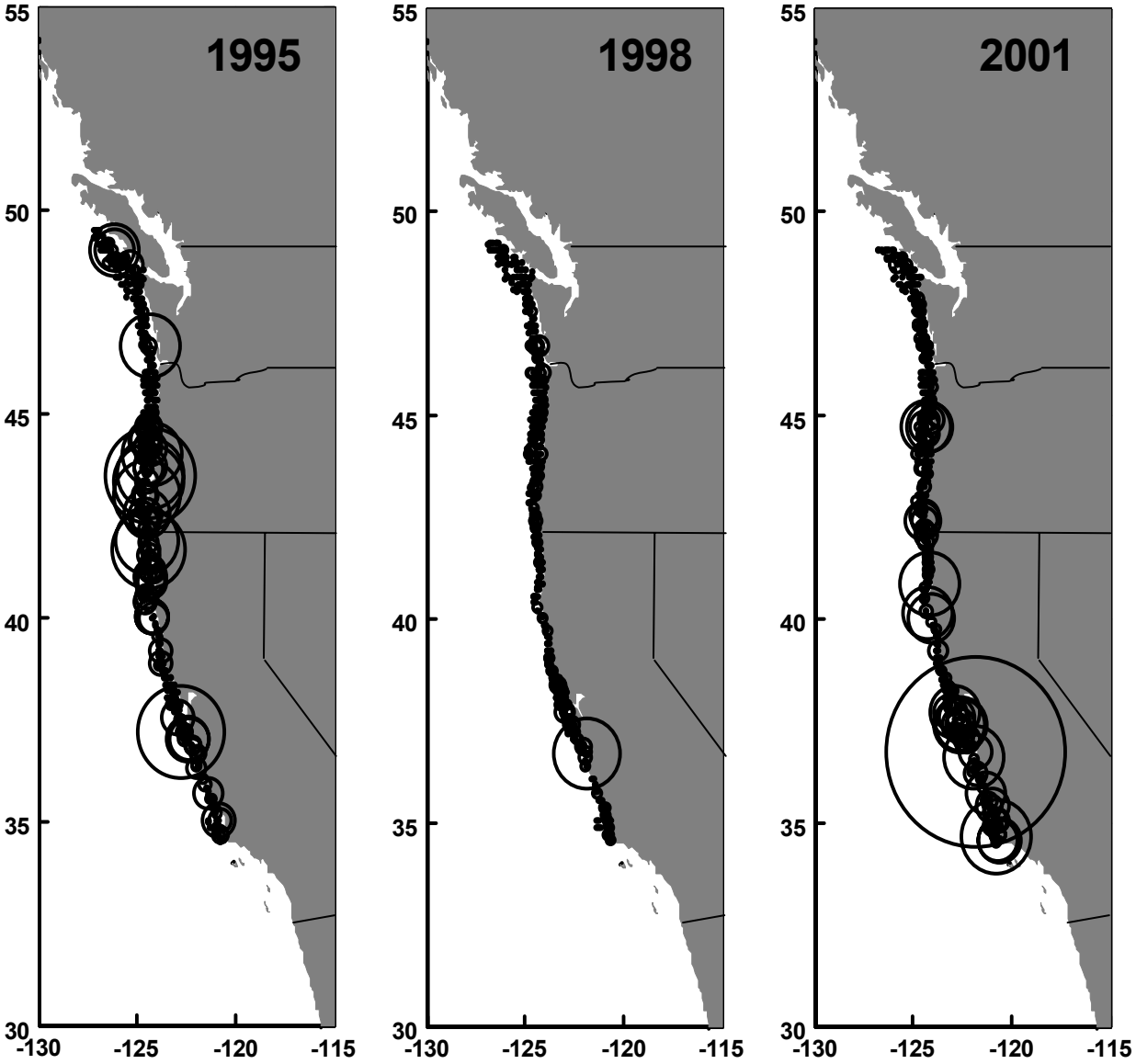

Figure 2-4. Expanding symbol plots of distribution and abundance of *Loligo opalescens* juveniles collected as part of the by-catch in the summer triennial groundfish survey conducted by NOAA Fisheries/NWFSC (from Reiss et al. in submission).

As briefly identified above, market squid, along with anchovy and sardine, are important as forage to predators at many trophic levels. Although it is not currently possible to estimate the total amount of squid used as forage in the California Current ecosystem or the size of squid populations necessary to sustain predator populations, the MSFMP contains the goal of providing adequate forage for dependent species. This goal is implemented through management measures that reserve a portion of the biomass as forage for all dependent species using such tools as fishery control rules and harvest replenishment areas.

Table 2-1. Known fish, bird, mammal and invertebrate predators of coastal pelagic species, including market squid. (Table 1.1.2-1 from Federal Coastal Pelagic Species FMP; Table 7A from CDFG Report to the Legislature).

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MARINE MAMMALS	MARINE BIRDS	MARINE FISH
Northern fur seal	Black-footed albatross	Northern anchovy
Guadalupe fur seal*	Fulmar	Pacific sardine
Steller sea lion	Sooty shearwater	Pacific whiting
California sea lion	Manx shearwater	Common thresher shark
Northern elephant seal	Short tailed shearwater	Bonito shark
Harbor seal	Pink footed shearwater	Soupfin shark
Common dolphin	Leach's Storm petrel	Blue shark
Harbor porpoise	Ashy Storm petrel*	Pacific electric ray
Dall's porpoise	Black Storm petrel	Silver (coho) salmon*
Pacific white-sided dolphin	Brown pelican*	King (Chinook) salmon*
Bottlenose dolphin	Double-crested cormorant	Steelhead*
Pilot whale	Brandt's cormorant	Rockfish (many species)
Blue whale*	Pelagic cormorant	Striped bass
Fin whale*	Glaucous-winged gull	Barred sand bass
Sei whale	Western gull	Kelp bass
Minke whale	Heerman's gull	Spotted sand bass
Pacific right whale*	Ring-billed gull	Ocean whitefish
Humpback whale*	California gull*	Jack mackerel
California gray whale	Black-legged kittiwake	Yellowtail
	Common murre	White seabass
	Pigeon guillemot	Queenfish
INVERTEBRATES	Marbled murrelet*	California corbina
Market squid	Craveri's murrelet	White croaker
Ocean squids	Xantus's murrelet*	Surfperches (many species)
	Ancient murrelet	California barracuda
	Cassin's auklet	Pacific (chub) mackerel
	Rhinoceros auklet*	Pacific bonito
	Horned puffin	Albacore
	Tufted puffin*	Bluefin tuna
	Bald eagle	Swordfish
	Osprey	Striped marlin
	Elegant tern*	Giant seabass
	Caspian tern	Lingcod
	Forster's tern	Scorpionfish
	Least tern*	Dogfish

* = endangered, threatened, or candidate species

2.1.7 Competition

Market squid feed with a variety of pelagic fish, namely anchovies, sardines, herring, and mackerel. They are often found together in commercial catch targeting these species; however, there is little information regarding the actual competition for

resources. Dense spawning aggregations of market squid may result in an increased incidence of cannibalism (Karpov and Cailliet 1978).

Trophic interactions between squid and higher-trophic-level fish are poorly understood. Among coastal pelagic finfish species (sardines, anchovies, and mackerel), it is not known if the value of market squid as a food source to adult predators outweighs the negative effects of predation by squid on larvae and juveniles of predator fish species plus competitive removal of phytoplankton, zooplankton and other fish.

2.1.8 Critical Habitat

The description and identification of Essential Fish Habitat for market squid is generalized because data are incomplete for this species. The CPS FMP describes the east-west geographic boundary to be all marine and estuarine waters from the shoreline along the California coast offshore to the limits of the exclusive economic zone (EEZ) and above the thermocline, where sea surface temperatures range between 50-79ºF, the upper tolerance of CPS finfish.

Market squid inhabit the inshore and offshore waters of the California Current from British Columbia to Baja California. The California Current is a region of transport, coastal jets, divergence, and upwelling. Changes in the Pacific Basin atmospheric pressure systems result in seasonal and interannual environmental variability within the California Current ecosystem. Variations are caused by local winds and Ekman transport, flows of the equatorward California Current, the poleward undercurrent, and the inshore countercurrent. Temporal variations associated with the California Current are on time scales of several years to decades [i.e., the El Niño Southern Oscillation (ENSO) and cold vs. warm water regimes]. ENSO and other temperature related events markedly alter flow and temperature of currents within the California Current system.

Refuges, preserves and marine sanctuaries (now termed marine protected areas and marine managed areas due to recent legislation) are areas that are legally defined and regulated by the state or federal government, with the primary intent of managing areas for their conservation, recreational, ecological, historical, research, educational, or aesthetic qualities. National marine sanctuaries specifically prohibit exploring for, developing, or producing oil, gas, or minerals within their boundaries. Two national marine sanctuaries, the Channel Islands National Marine Sanctuary and the Monterey Bay National Marine Sanctuary encompass the main fishing areas for market squid.

Non-spawning market squid are pelagic and believed to be associated with the deep scattering layer that migrates vertically to the upper levels of the water column at night. Spawning squid concentrate in dense schools near spawning grounds, but habitat requirements for spawning are not well understood. Spawning occurs over a wide depth range, but the extent and significance of spawning in deep water are unknown. Known market squid spawning grounds are characterized by a sandy substrate in shallow waters; major spawning grounds fished in California are located in Monterey Bay and near the Channel Islands. Egg cases are most often deposited at depths

between 18 and 55 m (CDFG-NOAA Fisheries unpublished data), but have been found at depths of 792 m. Adults and juveniles prefer oceanic salinities and are most abundant between temperatures of 50-60ºF (Roper and Sweeney 1984).

2.1.9 Status of the Stocks

Market squid population dynamics are poorly understood. Although some information exists on the coastwide distribution and abundance of market squid from fishery-independent midwater and bottom trawl surveys aimed at assessing other species, there is no good measure of annual recruitment success beyond information obtained from the fishery. Because fishing activity occurs only on shallow-water spawning aggregations, it is not apparent if landings reflect availability to the fishery, or overall stock size since squid have been documented at greater depths using other gear.

Historically, the squid resource was considered by some to be underutilized. Until improved estimates of abundance are available, the true status of the population will remain unknown. In 1998, a cooperative scientific research program between the Department and NOAA Fisheries was initiated and efforts to model the population began. This program may eventually give rise to a more thorough and detailed stock assessment similar to those for other coastal pelagic species.

2.1.10 Areas Involved

There are two major fishery areas in California. The northern fishery is centered in Monterey Bay, and squid are landed primarily at Monterey and Moss Landing. The northern fishery operates predominately within a half-mile of the Monterey Bay shoreline. The southern fishery targets a multitude of fishing spots including the Channel Islands and coastal areas from Point Conception south to La Jolla. Squid are landed chiefly at the ports of Ventura, Port Hueneme, San Pedro, and Terminal Island.

2.2 History of Exploitation

The commercial fishery has a long history in California, dating back to the mid-nineteenth century, although annual catches were usually less than 10,000 short tons (tons) until the 1960s (Table 2-2). During the 1980s, California's squid fishery grew rapidly in fleet size and landings when international demand for squid increased due to declining squid fisheries in other parts of the world (CDFG 2001c). In 1997, a permit was created for the squid fishery and the rapid growth of fleet size was halted by a moratorium on new permits. Although it is not known when recreational fisheries in California started to use market squid as bait, it is currently used as either live or dead bait for recreational fisheries throughout the state.

Table 2-2. Historical market squid landings in tons for California divided at Point Conception into northern and southern fisheries. The market squid season is from 1 April through 31 March of the following year. Source: CDFG Landing Receipts.

Season	Northern fishery	Southern fishery	Total landings

Table 2-2. Historical market squid landings in tons for California divided at Point Conception into northern and southern fisheries. The market squid season is from 1 April through 31 March of the following year. Source: CDFG Landing Receipts.

Season	Northern fishery	Southern fishery	Total landings
1927-1928	1567	4	1571
1928-1929	686	44	730
1929-1930	2,303	16	2,319
1930-1931	5,494	16	5,510
1931-1932	792	71	863
1932-1933	2,072	28	2,100
1933-1934	430	4	434
1934-1935	736	19	755
1935-1936	329	19	347
1936-1937	451	17	469
1937-1938	245	61	306
1938-1939	754	11	765
1939-1940	522	53	575
1940-1941	818	86	904
1941-1942	694	47	741
1942-1943	406	34	440
1943-1944	4,529	18	4,546
1944-1945	5,435	38	5,472
1945-1946	7,586	27	7,613
1946-1947	19,777	18	19,795
1947-1948	8,728	64	8,792
1948-1949	7,599	59	7,658
1949-1950	3,087	2	3,089
1950-1951	2,997	2	2,999
1951-1952	5,844	374	6,219
1952-1953	1,746	2,649	4,394
1953-1954	2,076	391	2,467
1954-1955	3,772	77	3,849
1955-1956	6,714	119	6,833
1956-1957	9,828	478	10,306
1957-1958	5,496	1,753	7,249
1958-1959	1,902	2,848	4,750
1959-1960	7,140	94	7,235
1960-1961	1,103	996	2,099
1961-1962	1,987	4,075	6,062
1962-1963	2,886	2,028	4,914
1963-1964	3,174	1,641	4,815
1964-1965	4,551	5,223	9,774
1965-1966	4,439	4,508	8,947
1966-1967	5,597	4,211	9,808
1967-1968	5,617	6,088	11,705
1968-1969	7,289	2,668	9,957

Table 2-2. Historical market squid landings in tons for California divided at Point Conception into northern and southern fisheries. The market squid season is from 1 April through 31 March of the following year. Source: CDFG Landing Receipts.

Season	Northern fishery	Southern fishery	Total landings
1969-1970	5,780	6,186	11,966
1970-1971	4,314	8,861	13,175
1971-1972	8,328	4,475	12,803
1972-1973	6,124	5,057	11,181
1973-1974	621	7,696	8,317
1974-1975	7,248	5,302	12,549
1975-1976	2,495	10,563	13,058
1976-1977	2,511	6,587	9,098
1977-1978	2,235	12,050	14,285
1978-1979	10,343	8,680	19,024
1979-1980	14,169	7,213	21,381
1980-1981	7,860	12,087	19,947
1981-1982	14,132	11,700	25,833
1982-1983	11,697	1,516	13,213
1983-1984	1,061	27	1,087
1984-1985	549	804	1,354
1985-1986	4,276	10,100	14,376
1986-1987	6,967	18,636	25,603
1987-1988	6,632	18,582	25,214
1988-1989	5,765	42,430	48,195
1989-1990	7,829	25,222	33,051
1990-1991	8,871	23,602	32,472
1991-1992	9,013	29,653	38,666
1992-1993	9,450	9,343	18,793
1993-1994	10,012	44,440	54,452
1994-1995	19,103	44,489	63,592
1995-1996	3,676	90,157	93,833
1996-1997	5,828	118,481	124,309
1997-1998	9,275	1,623	10,898
1998-1999	26	11,673	11,699
1999-2000	308	126,464	126,772
2000-2001	7,730	115,681	123,411
2001-2002	10,094	92,621	102,715
2002-2003	27,828	19,166	46,994

2.2.1 Description of User Groups

2.2.1.1 Commercial Fishery

California's market squid fishery began in 1863; Chinese immigrants harvested small quantities of squid from Monterey Bay (Dickerson and Leos 1992). Skiffs were used to encircle a net around another skiff that used a torch to attract the squid to the surface.

The product was dried and exported to China. In 1905, Italian immigrant fishermen introduced the more efficient lampara net. The lampara net (Table 2-3) was the only legal form of round haul gear in the southern bight of Monterey Bay until 1989. Once purse and drum seines were legalized for use in this district, the squid fleet switched gear types and the lampara became obsolete. In CDFG Districts 16 and 17 (Monterey and Santa Cruz Counties), attracting lights were prohibited between 1959 and 1988; in 1989 lights were again allowed in the northern fishery. Catch in the northern fishery had not expanded in terms of volume or location until the 2002-2003 season. Excluding El Niño events, the number of vessels participating in the northern fishery landing greater than two tons daily of market squid has remained relatively constant (Figure 2-5) while the number of vessels increased in the 1990s (Figure 2-6).

Table 2-3. Description of gear types.

Gear type	Description
Purse seine	A round haul net with a "purse" line to close the bottom of the net. One end is attached to a skiff and the deploying vessel encircles the squid. The other end of the net is brought to the deploying vessel and the purse line is drawn, closing the bottom of the net to prevent escaping squid.
Drum seine	Like a purse seine, but a large drum stores, deploys and retrieves the net.
Lampara	A round haul net with the sections of netting made and joined to create bagging. The net is pushed beneath squid to encircle it from each side. The "wings" of the net are pulled back to the boat and the squid end up in the bag portion of the net. This gear has no arrangement for pursing.
Brail	A large dip net sometimes used with the assistance of the vessel's hydraulics.

During the 1970s brail vessels were the major harvesters in the southern California market squid fishery, using a power-assisted brail or dip net in conjunction with attracting lights (Kato and Hardwick 1975). In 1977, the fleet shifted from using brail vessels to purse seine vessels (Vojkovich 1998). Vessels brailing for squid still land a small portion of the catch (less than 2.0% in 2000-2001 season). These vessels have the advantage of fishing in some areas that are closed to roundhaul gear and can land smaller volumes at a higher value. However, purse seine and drum seine vessels are more effective at landing large volumes of squid and by the early 1990s, the purse seine became the dominant gear on the entire coast, with the drum seine gaining popularity by the mid-1990s (Figure 2-7).

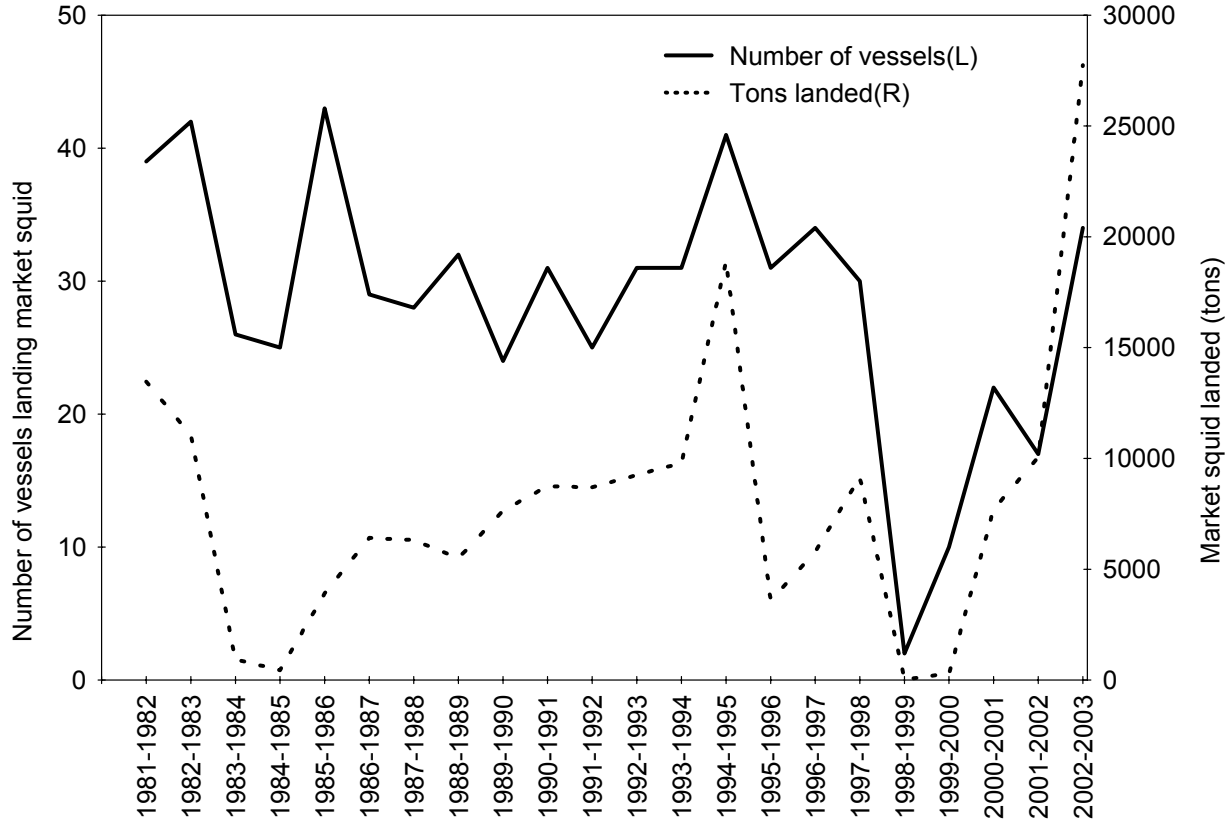

Figure 2-5. Number of vessels and market squid landings by season for Northern California. Source: CDFG Landing Receipts; note: data for 2002-2003 season is preliminary.

According to Department records, the average purse seine vessel length is 18.9 m (62 feet) and 81 gross tons. The average hold capacity is 84 tons. During the past three years, over two-thirds of the fleet (70%) used a purse seine, 23% used a drum seine and 4% used brail gear. Nearly all vessels use side-scan sonar and fathometers. The average vessel power is 428 HP and auxiliary power is148 HP. Most vessels (82%) use refrigerated seawater to keep their catch cold, while others (live bait vessels) use circulated seawater, brine or no cooling system at all. The average purse seine net is 381 m (1250 feet) long with a depth of 48 m (156 feet). The stretched mesh size is one inch.

In most cases, squid seiners work with light boats. A light boat is typically a smaller vessel with several high-powered lights located at various levels around the vessel. The purpose of the lights is to attract and aggregate spawning squid to surface waters. The light boat actively searches for squid. Once squid are located and aggregated, the light boat will signal the seiner to deploy its net, encircling the light boat, in order to catch the squid located under the lights.

According to logbook records, the average light boat is 11.8 m (39 feet) in length with a gross tonnage of 19 tons. Wattage for squid attracting lights averages approximately 22,500 watts (30,000 watts is the legal maximum). Nearly all light boats use side-scan sonar and fathometers. Light boat power and auxiliary power average 379 HP and 63 HP, respectively.

Squid fishing supplements the income of many seine vessels from southern California that also participate in the tuna and CPS fisheries. Many vessels in the southern fishery have homeports in the states of Alaska, Washington and Oregon and participate in salmon, herring and sardine fisheries in these other states. In recent years, some vessels from the squid fishery participated in a high value sardine fishery off the Columbia River at the border of Oregon and Washington. Many light boats also participate in other local fisheries that do not use attracting lights such as herring, hook-and-line and gillnet. Declines in other fisheries led to an influx of fishing vessels from other states in the 1990s. Some fishermen have complained about user conflict and territorial disputes between "local" and out-of-state fishermen. Non permitted vessels, including vessels in other fisheries (such as trawlers) that periodically catch small volumes of squid, are allowed to make landings of up to two tons daily (Table 2-4).

The number of businesses purchasing squid has remained constant since the early 1980s (mean = 54; range 41-86), however, since the 1994-1995 season, the majority (80% or more) of the squid purchased was bought by nine or fewer dealers. The majority (approximately 72%) of the dealers purchase less than 100 tons per year.

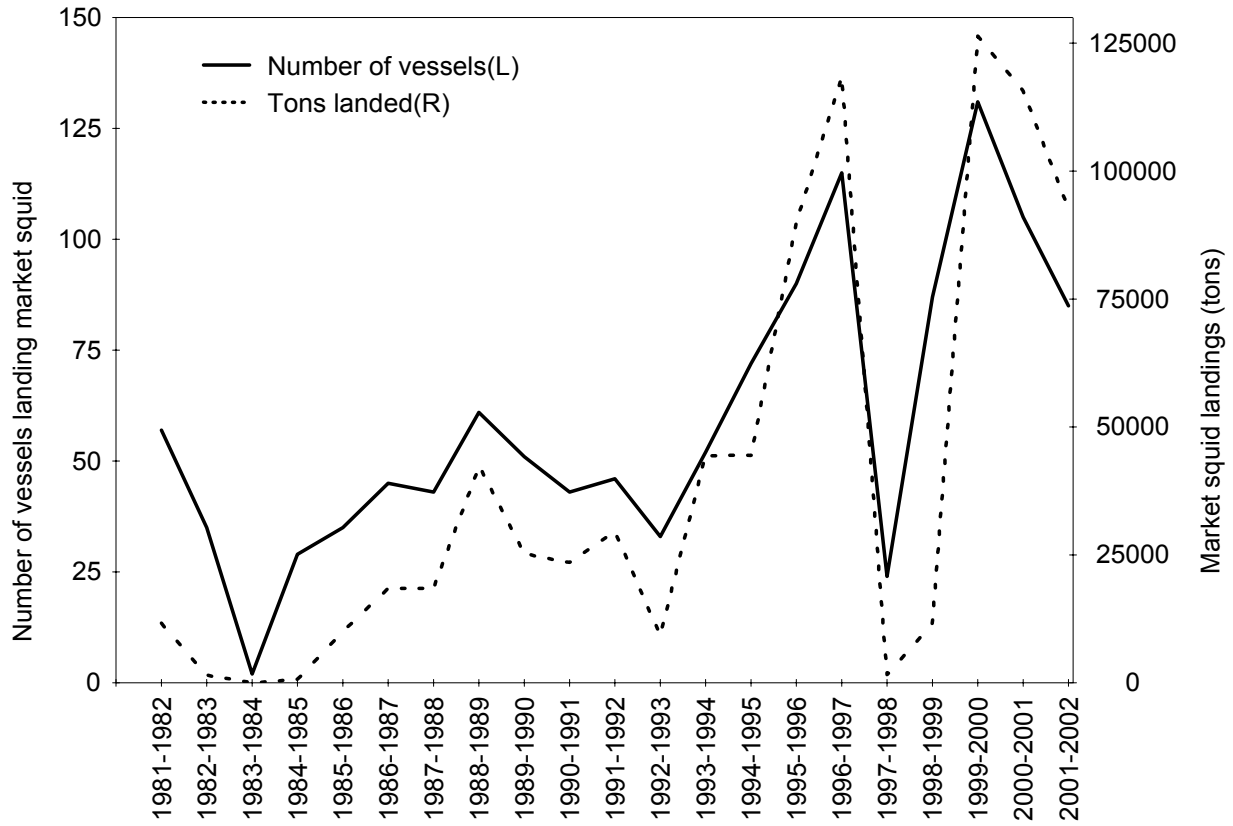

Figure 2-6. Number of vessels and market squid landings by season for Southern California. Source: CDFG Landing Receipts.

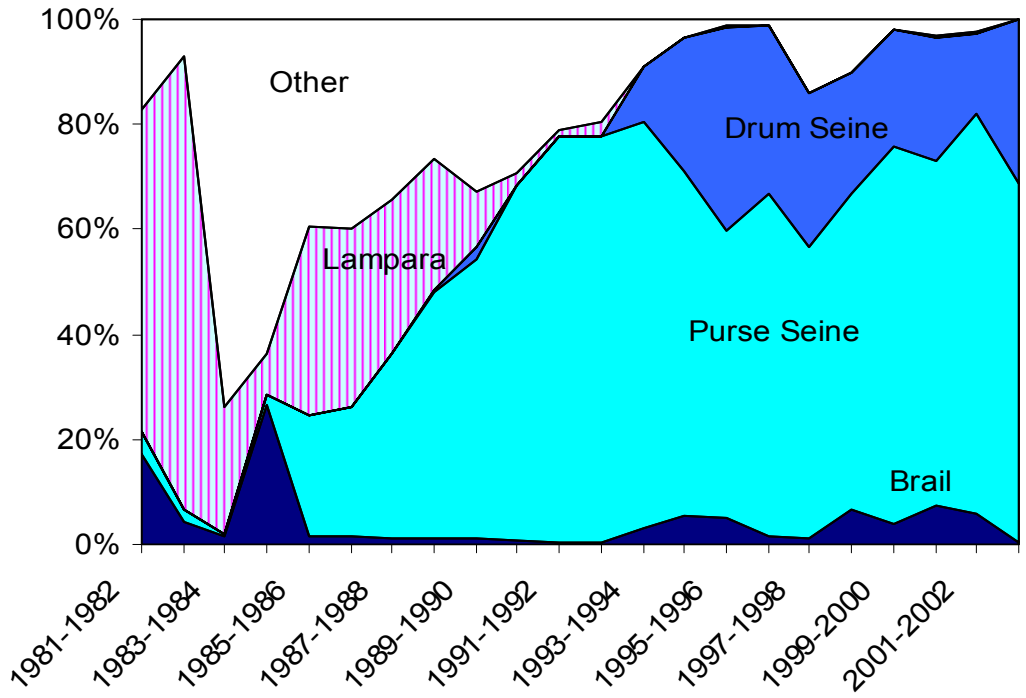

Figure 2-7. Percent of landings by season and gear type (note: "Other" includes, but is not limited to jig, hook and line, trawl nets, and other roundhaul nets). Source: CDFG Landing Receipts.

Table 2-4. Historical California landing receipt information for permitted and non-permitted vessels, 1981-1982 to 2002-2003. . Vessels fishing for squid were not required to have a squid fishing permit until the 1998-1999 season; this table shows the historical activity by the vessels currently permitted as of the 2002-2003 squid fishing season. Source: CDFG Landing Receipts.

Season	Landings (tons)	Landings (tons) by current permittees	Percent landings made by permittees	Number of vessels	Number of currently permitted vessels
1980-1981	5,768	1,459	25.3%	55	10
1981-1982	25,851	11,349	43.9%	152	31
1982-1983	13,213	7,049	53.3%	125	28
1983-1984	1,087	740	68.1%	81	17
1984-1985	1,354	476	35.1%	95	21
1985-1986	14,376	8,833	61.4%	126	34
1986-1987	25,603	14,184	55.4%	122	34
1987-1988	25,214	15,547	61.7%	117	37
1988-1989	48,195	31,371	65.1%	119	43
1989-1990	33,051	22,705	68.7%	100	39
1990-1991	32,472	24,764	76.3%	102	41
1991-1992	38,666	30,503	78.9%	85	40
1992-1993	18,793	16,176	86.1%	82	40
1993-1994	54,452	44,335	81.4%	92	45
1994-1995	63,592	51,006	80.2%	110	54
1995-1996	93,833	72,749	77.5%	128	65
1996-1997	124,315	95,082	76.5%	143	77

Table 2-4. Historical California landing receipt information for permitted and non-permitted vessels, 1981-1982 to 2002-2003. . Vessels fishing for squid were not required to have a squid fishing permit until the 1998-1999 season; this table shows the historical activity by the vessels currently permitted as of the 2002-2003 squid fishing season. Source: CDFG Landing Receipts.

Season	Landings (tons)	Landings (tons) by current permittees	Percent landings made by permittees	Number of vessels	Number of currently permitted vessels
1997-1998	10,898	9,917	91.0%	86	46
1998-1999	11,699	9,433	80.6%	117	67
1999-2000	127,248	107,934	84.8%	168	95
2000-2001	124,379	108,831	87.5%	152	85
2001-2002	102,667	96,757	94.2%	118	85
2002-2003	46,970	45,031	95.9%	105	78

2.2.1.2 Recreational Fishery

The other market squid user group is the recreational sector of the fishery. Market squid are primarily caught by bait haulers using seine, lampara or brail nets. This small volume of squid is a high value fishery, which supplies bait to recreational fisheries along the California coast, primarily in southern California (CDFG 2001b). Live bait is sold from the catcher vessel at sea or from one of the many harbor-based bait dealerships. Sport fishing vessels and privately owned skiffs catch their own squid bait by using attracting lights and brail nets and/or rod and reel. Live and dead squid are ideal bait for a variety of California sport fisheries, especially rockfish and white seabass.

2.2.2 Fishing Effort

2.2.2.1 Commercial Fishing Effort

In the 1990s, the market squid fishery ranked highest among the state's commercial fisheries: squid ranked number one in landings for six years and number one for dollars paid ex-vessel for three years (CDFG 2001c). Although quite successful, the commercial squid fishery is unpredictable due to environmental (e.g., El Niño) and market conditions.

During an El Niño event (i.e., 1997-1998), squid availability declines along with fishing effort and catch. In years when squid are readily available, fishing effort appears to be determined by market conditions. Vessel participation is at its greatest during the late fall and early winter for the southern fishery and during the summer for the northern fishery (Figure 2-8). When squid processors have full freezers or the demand for California squid is low, vessels are generally put on market-imposed limits, and ex-vessel prices may be lowered. As squid availability declines as the season progresses, many vessels leave for other fisheries. If ex-vessel prices drop too low, effort may also drop because of less economic incentive to fish.

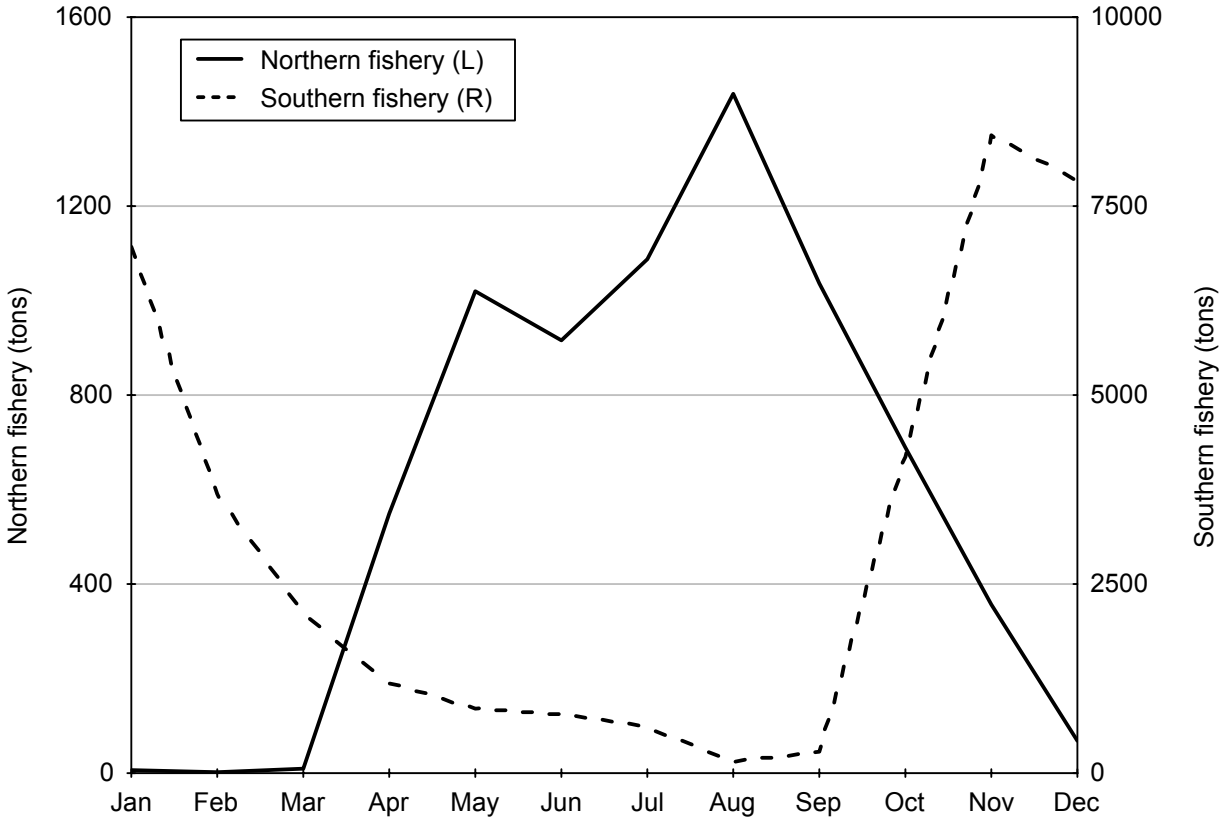

Figure 2-8. Average monthly landings in tons for the squid fishery divided at Point Conception into northern (left axis) and southern (right axis) fisheries for the period of 1981 through 2001. Source: CDFG Landing Receipts.

Although market squid may be available in commercial quantities from Baja California to Oregon, the fishery is centered in two areas of California: Monterey Bay and the Channel Islands off southern California. The earliest fishery, in Monterey Bay, caught less than 1,000 tons per year from 1916 (when the Department began keeping records) to 1923 (Dickerson and Leos 1992). From 1924 to 1932, landings averaged more than 2,000 tons per year. Most of this catch was dried and exported to China; some was used domestically as canned or frozen product. The Asian market closed in 1933 due to financial conditions and the domestic market supported the Monterey fishery for many years. Landings in California were minimal until 1942 when demand from international aid programs triggered a rise in the need for squid the following year. Landings peaked at close to 20,000 tons in the 1946-1947 season, then averaged 9,100 tons until the 1981-1982 season when greater than 25,000 tons were landed (Table 2-2). Before the 1960s, the majority of squid landings were in the Monterey Bay area. In 1961, the fishery in southern California experienced a dramatic increase in landings. The southern fishery centers around the northern Channel Islands, Santa Catalina Island, and southern coastal nearshore areas (Hill and Yaremko 1997).

Since the early 1980s, landings in southern California have exceeded those of the northern fishery (Figure 2-9; also see Table 2-2). Fishery landings reached a peak of

126,772 tons in the 1999-2000 season. The rapid fishery expansion of the last 25 years is a result of rising demand for squid in foreign markets, especially Europe and China.

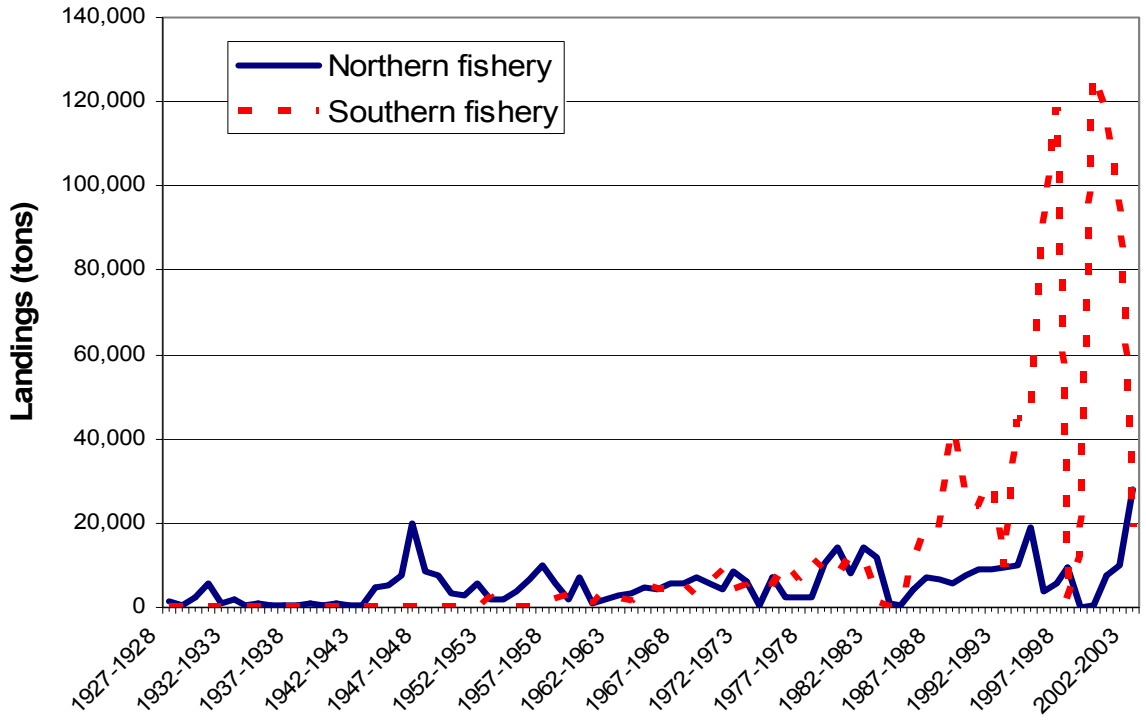

Figure 2-9. Market squid landings from 1927-1928 through 2002-2003 seasons showing the increase in landings for the fishery south of Point Conception. Source: CDFG Landing Receipts.

Because the squid fishery was primarily an open-access fishery before 1998 and due to recent increases in statewide landings, legislation was enacted to ensure the sustainability of the squid resource and the marine life that depends on squid. This legislation required the purchase of an annual permit to land more than two tons or to attract squid by using light for purposes of commercial squid harvest. Eligibility has been determined by the purchase of a permit in the initial 1998-1999 season and subsequently from the previous year (Table 2-5). In the 2002-2003 season, there were 185 vessel permits and 40 light boat owner permits issued. Since 1998, the number of vessel and light boat owner permits has declined.

Table 2-5. Vessel and light boat owner's permit issuances, 1998-99 to 2002-03 seasons. Source: CDFG Landing Receipts.

Season	Vessel Permits Issued	Vessel Attrition (%)	Light Boat Owner Permits Issued	Light Boat Attrition (%)
1998-1999	248	--	53	--
1999-2000	218	12.1	51	3.8
2000-2001	195	9.6	50	2.0
2001-2002	195	0.0	44	12.0
2002-2003	185	5.1	40	9.1

Not all permitted vessels were active in the fishery during the moratorium period. Despite the large number of permits issued, the current squid fleet consists of approximately 60 dedicated seiners. As with many fisheries, a select number of vessels made the majority of the catch. In the last four seasons, only 30, 34, 28, and 21 permitted vessels, respectively, made 75% of the catch.

2.2.2.2 Recreational Fishing Effort

There are insufficient data to describe recreational fishing effort for market squid. Live bait logs used by commercial vessels to voluntarily report catch (e.g., northern anchovy, Pacific sardine) do regularly report squid taken. Additionally, some light boat operators record scooping live squid for bait in their logbooks. Preliminary data for the 2001-2002 season recorded 49 tons of market squid taken as live bait, less than 0.05% of the total harvest. Again, these data are voluntary and should be considered as a minimum amount of squid harvested for bait.

2.2.3 Fishery Impacts

The adverse effects from fishing activities may include physical, chemical and biological alterations of the substrate, loss of and or injury to benthic organisms, prey species and their habitat, and other components of the ecosystem. FMPs must include management measures that minimize adverse effects on marine ecosystems from fishing, to the extent practicable, and to identify conservation and enhancement measures. In addition, they must contain an assessment of the potential adverse effects of all fishing activities and should consider the relative impacts of all fishing equipment used in varying habitats (Bargmann et. al. 1998).

Fishing for market squid could have important trophic implications and other ecological impacts. There is concern over the use of chains as a seine weight in the commercial fishery. Chains have the potential of digging deeper into the ocean floor than the suggested alternatives, such as small diameter cables (Hastings and MacWilliams 1999). Net bottoms may also scrape the ocean floor and do harm to squid eggs. A suggestion has been made for a maximum depth and length of net to avoid disturbance to egg cases or to require that the net shall be no deeper that the depth fished. Further, there is concern for squid caught which have not yet spawned by targeting schools of squid using sonar which are in transit to spawning grounds.

Bycatch is minimal in the commercial market squid fishery, although it cannot be avoided entirely. Through the Department's port sampling program, 886 of 2,402 samples (37%) collected between October 1998 and October 2003 contained incidentally caught fish and invertebrates (Table 2-6). Two or more species were observed as bycatch in 47% of landings with bycatch. Most of this bycatch was other coastal pelagic species, including Pacific sardine, Pacific mackerel, northern anchovy and jack mackerel. Approximately 3.2% of sampled landings contained squid egg cases. Previous drafts of this MSFMP reported that incidental catch of squid eggs was 2%. In addition, squid eggs occurred in 8.3% of the Monterey samples. This higher level of observed egg cases is most likely due to the shallower nature of the northern

fishery and is a source of concern. Under the proposed management strategy, the fishery is monitored by evaluating escapement of squid eggs from the fishery. If the fishery damages squid spawning beds, and this damage is a significant source of egg mortality, the monitoring program will be biased unless this additional source of mortality is accounted for.

Currently, the type of net used to fish for squid is unregulated, although purse seines used for squid typically do not hang as deep as purse seines used for other species, so contact with the bottom is reduced. Incidental catches of squid eggs and other species increase in the squid fishery when the nets are set in shallower water (less than 40 m), where bottom contact may occur (Lutz and Pendleton 2001). Damage to the substrate, and thus, mortality of squid eggs associated with purse seining for squid has not been quantified.

A research study to measure the effect of purse seine fishing on squid spawning grounds has been undertaken by NOAA Fisheries and the Department. So far, preliminary results of this study are unavailable. The study will use three approaches to measure the effect of purse seines on squid beds: 1) Direct observation of egg capsule bycatch in the net from an observation boat; 2) ROV surveys of the squid egg capsule distributions in fished and unfished habitats, and 3) Determination of the natural mortality of squid eggs in heavily fished areas versus unfished areas. If current fishing practices are shown to affect squid egg survival, changes in gear or fishing practices can be proposed to the squid fishing industry to find the most efficient way to reduce the risk of egg loss due to fishery gear interaction. Potential future management options may include altering the mesh size or depth of the net, or closing some of the shallow water habitats to fishing.

Less than 2 percent of the observed landings contained species that are prohibited from being landed using seine gear (e.g., barracuda, yellowtail). In terms of species of concern, there have been seven observations of Chinook (King) salmon representing 1.6% of observed landings in Monterey as well as one observation of salmon (species unknown). In addition, bocaccio was observed in 1.2% of the Monterey landings.

Table 2-6. Percent frequency-of-occurrence of observed market squid incidental catch by port area. A total of 2,402 port samples were taken between October 1998 and October 2003. Source: CDFG Port Sampling Data.

Common Name	Total All Ports	Monterey Moss Landing	Santa Barbara Ventura	San Pedro Terminal Is.
PACIFIC SARDINE	18.5	9.5	18.9	21.5
PACIFIC MACKEREL	6.9	2.3	6.0	9.7
NORTHERN ANCHOVY	5.0	3.9	4.0	6.2
JACK MACKEREL	4.0	6.7	0.1	6.6
MARKET SQUID EGGS	**3.2**	**8.3**	**1.7**	**2.3**
PACIFIC BUTTERFISH	2.0	4.4	1.8	1.0
BAT RAY	1.9	1.4	2.3	1.6
JACKSMELT	1.3	6.7	0.1	0.1
CALIFORNIA BARRACUDA	**0.9**		**1.0**	**1.1**
PACIFIC ELECTRIC RAY	0.9	4.9		

Table 2-6. Percent frequency-of-occurrence of observed market squid incidental catch by port area. A total of 2,402 port samples were taken between October 1998 and October 2003. Source: CDFG Port Sampling Data.

Common Name	Total All Ports	Monterey Moss Landing	Santa Barbara Ventura	San Pedro Terminal Is.
PELAGIC RED CRAB	0.9		2.0	0.1
DUNGENESS CRAB	0.7	3.9		
SANDDAB	0.6	2.1	0.4	0.2
SEA STAR	0.6	0.9	0.1	0.9
SCULPIN	0.6			1.4
HORN SHARK	0.4			0.9
TURBOT	0.4	1.9		
SOLE	0.4		0.6	0.3
CABEZON	0.3	0.2	0.1	0.6
ROCK CRAB	0.3		0.5	0.3
CHINOOK (KING) SALMON	**0.3**	**1.6**		
MEXICAN POMPANO	0.3		0.6	0.1
CALIFORNIA HALIBUT	0.3	0.5	0.1	0.4
RAY	0.3	0.2		0.6
MIDSHIPMAN	0.2	0.2		0.5
PACIFIC SANDDAB	0.2	0.7		0.3
BOCACCIO	**0.2**	**1.2**		
QUEENFISH	0.2		0.2	0.2
SMELT	0.2			0.4
WHITE CROAKER	0.2			0.4
PACIFIC SAURY	0.2	0.9		
FLYINGFISH	0.2		0.1	0.3
ROCKFISH	0.2	0.5	0.1	0.1
PACIFIC HERRING	0.2	0.9		
ENGLISH SOLE	0.2	0.7		0.1
MISCELLANEOUS FISH	0.2			0.4
CURLFIN TURBOT	0.1	0.5		0.1
MACKEREL UNCLASSIFIED	0.1	0.5	0.1	
OCTOPUS	0.1		0.2	0.1
SALEMA	0.1	0.7		
BLUE SHARK	0.1		0.2	
HORNYHEAD TURBOT	0.1			0.2
SPECKLED SANDDAB	0.1	0.2		0.1
SURFPERCH	0.1	0.5		
SEA URCHIN	0.1		0.2	
CALIFORNIA LIZARDFISH	0.1			0.2
SAND SOLE	0.1	0.5		
DIAMOND TURBOT	0.1			0.2
BARRED SAND BASS	0.1			0.2
BIGMOUTH SOLE	0.1			0.2
CALIFORNIA SPINY LOBSTER	0.0		0.1	
BLACKSMITH	0.0			0.1
GREENSPOTTED ROCKFISH	0.0		0.1	
BIG SKATE	0.0	0.2		
WAHOO	0.0			0.1

Table 2-6. Percent frequency-of-occurrence of observed market squid incidental catch by port area. A total of 2,402 port samples were taken between October 1998 and October 2003. Source: CDFG Port Sampling Data.

Common Name	Total All Ports	Monterey Moss Landing	Santa Barbara Ventura	San Pedro Terminal Is.
BLUE ROCKFISH	0.0	0.2		
YELLOWTAIL	**0.0**			**0.1**
SKATE	0.0		0.1	
SHRIMP UNCLASSIFIED	0.0			0.1
SHOVELNOSE GUITARFISH	0.0			0.1
SALMON	**0.0**	0.2		
Total Port Samples Taken	**2,402**	**415**	**988**	**999**

2.3 Social and Economic Characteristics of the Market Squid Fishery

California's fishing industry ranks among the top five seafood producing states in the nation (CSC 1997), and growth or decline in commercial fishing, including the market squid industry, affects production, trade and employment throughout the California economy. California market squid is the most valuable commercial fishery product to the state in terms of volume and revenue, generating more than $35 million ex-vessel revenue in recent years. Among California fishery exports, market squid ranked first by volume and value; further, market squid has ranked first in both volume and revenue several times during the 1990s (Table 2-7). The vast majority of squid is frozen for export to China, Japan and Europe where it is used mainly for human consumption. Minor amounts are sold fresh or canned.

Table 2-7. Market squid volume and value exported and respective rankings of California fishery exports from 1990 through 2000 (last year data available). Source: NOAA Fisheries.

Year	Squid exported (tons)	Export value*	Rank by volume	Rank by value	Percent catch exported
1989	5,267	$5,667,283	1	7	11.7
1990	4,571	$4,110,021	2	10	14.6
1991	2,619	$2,637,344	12	20	6.4
1992	4,187	$3,938,031	2	8	29.0
1993	4,569	$5,448,155	1	6	9.7
1994	15,801	$15,817,174	1	3	25.8
1995	24,107	$21,196,325	1	1	30.2
1996	36,377	$32,802,620	1	2	41.1
1997	49,745	$45,989,317	1	1	64.2
1998	1,554	$2,109,087	8	20	48.7
1999	37,411	$36,355,586	1	1	29.8
2000	92,701	$71,637,625	1	1	75.2

*Note: export value not adjusted for inflation.

The role of international buyers in the success of the California market squid fishery is substantial. After decades of generally low catches, volume increased during the 1990s because of new markets and higher prices. Landings and ex-vessel revenue declined during the 1997-1998 El Niño when squid became harder to catch. In 1999, overseas markets collapsed due to poor economic conditions in Asia. Since then, there has been some recovery of the Asian market, although demand is affected greatly by

performance of other worldwide fisheries, particularly the Falkland Islands *Loligo gahi* fishery.

There are three major port areas associated with California's commercial market squid fishing industry (Table 2-8): Northern California (Monterey County); Santa Barbara port area (Ventura and Santa Barbara Counties); and Los Angeles port area (Los Angeles and Orange Counties).

Table 2-8. Market squid landings (in tons) by port area (N-SFO = counties north of San Francisco; SFO = San Francisco County, M/SC = Monterey and Santa Cruz Counties; SLO = San Luis Obispo County; SB/VE = Santa Barbara and Ventura Counties; LA/OC = Los Angeles and Orange Counties; SD = San Diego County). Source: CDFG Landing Receipts.

Season	N-SFO	SFO	M/SC	SLO	SB/VE	LA/OC	SD	Total
1990-1991	1	142	8,728	<1	13,201	10,400	<1	32,472
1991-1992	2	1,622	7,389	<1	18,098	11,554	0	38,666
1992-1993	<1	2,698	6,751	1	7,297	2,028	18	18,793
1993-1994	<1	1,122	6,643	2,247	25,571	18,869	<1	54,452
1994-1995	77	2,464	15,021	1,540	32,685	11,802	2	63,592
1995-1996	2	823	2,700	151	67,824	22,331	2	93,833
1996-1997	0	367	5,235	226	90,039	28,441	1	124,309
1997-1998	4	226	9,045	<1	1,593	28	2	10,898
1998-1999				10	6,948	1,584		8,543
1999-2000	0	6	332	8	85,134	41,758	10	127,248
2000-2001	1	0	7,854	19	67,542	48,917	45	124,378
2001-2002	0	309	8,539	68	27,583	33,363		69,862
2002-2003	4	953	26,478	393	15,121	4,066		47,016

Since the 1993-1994 fishing season, the Santa Barbara and Los Angeles port areas have received the bulk of market squid revenues, with the highest revenues coming into the ports of San Pedro, Port Hueneme and Ventura (Table 2-9). Since the 1981-1982 season, these three areas account for an average of 98% of all squid landings except during El Niño periods (1982-1983 – 53% and 1992-1993 – 86%) when squid landings were minimal. Based on landings, other ports where squid are landed landing are of minor economic importance.

Table 2-9. Dollars paid ex-vessel for market squid by port area (N-SFO = counties north of San Francisco; SFO = San Francisco County, M/SC = Monterey and Santa Cruz Counties; SLO = San Luis Obispo County; SB/VE = Santa Barbara and Ventura Counties; LA/OC = Los Angeles and Orange Counties; SD = San Diego County). *Note: Dollars not adjusted for inflation. Source: CDFG Landing Receipts.

Season	N-SFO	SFO	M/SC	SLO	SB/VE	LA/OC	SD	Total
90-91	$144	$30,691	$1,299,765	$59	$1,223,192	$1,343,869	$643	$3,898,362
91-92	$1,452	$344,122	$873,987	$51	$830,200	$1,137,595	$0	$3,187,407
92-93	$40	$452,087	$652,164	$163	$764,033	$444,441	$3,612	$2,316,541
93-94	$6	$320,948	$1,012,803	$505,792	$2,612,486	$2,923,770	$0	$7,375,804
94-95	$17,477	$633,318	$2,807,522	$453,583	$8,149,029	$2,607,151	$306	$14,668,386

Table 2-9. Dollars paid ex-vessel for market squid by port area (N-SFO = counties north of San Francisco; SFO = San Francisco County, M/SC = Monterey and Santa Cruz Counties; SLO = San Luis Obispo County; SB/VE = Santa Barbara and Ventura Counties; LA/OC = Los Angeles and Orange Counties; SD = San Diego County). *Note: Dollars not adjusted for inflation. Source: CDFG Landing Receipts.

Season	N-SFO	SFO	M/SC	SLO	SB/VE	LA/OC	SD	Total
95-96	$463	$214,959	$432,174	$21,301	$13,432,243	$5,544,538	$50	$19,645,729
96-97	$0	$12,160	$521,737	$58,681	$14,810,588	$8,354,422	$262	$23,757,850
97-98	$2,180	$60,241	$2,136,685	$10	$429,861	$19,499	$525	$2,649,001
98-99				$621	$2,969,874	$749,300		$3,719,794
99-00	$6	$1,774	$79,518	$4,024	$24,883,285	$11,120,763	$7,000	$36,096,369
00-01	$16	$0	$1,881,726	$1,912	$11,609,928	$10,652,521	$12,683	$24,158,785
01-02	$0	$74,049	$1,773,494	$13,688	$4,774,247	$6,813,077		$13,448,556
02-03	$1,262	$214,582	$6,525,785	$76,546	$4,068,682	$1,171,035		$12,057,892

Generally, ex-vessel revenues have closely paralleled landings until the 2000-2001 season when dollars paid ex-vessel clearly dropped (Figure 2-10). Although the volume of squid produced by California markets is dependent on the international market, the price paid to fishermen can influence both effort and overall volume of catch. Additionally, price paid to fishermen depends on market demand as well as the availability of the resource. When volume of catch is low, the price paid per ton exceeds $500 per ton during the 1997-1998 and 2002-2003 El Niño events. When volume is high, the price may be as low as $100 per ton. Squid taken by brail and in small volumes tends to receive a better price. Often, the price of squid will start high at the beginning of the southern California fishery, and decline as the frozen product begins to accumulate in cold storage facilities. This may result in a reduced incentive for fishermen to fish later in the season. Therefore, declines in landings for springtime months may reflect a reduction in the availability of squid as well as reduced effort. Additionally, many vessels participating in other fisheries (e.g. salmon, CPS finfish) will return to other ports during spring months. California markets (processors) play a role in determining the composition of the squid fleet. Although there are many California vessels that have historically participated in the fishery that are still active, there is an increasing proportion of fishery participants from Alaska, Washington and Oregon, reflecting a willingness of the processors to employ these vessels.

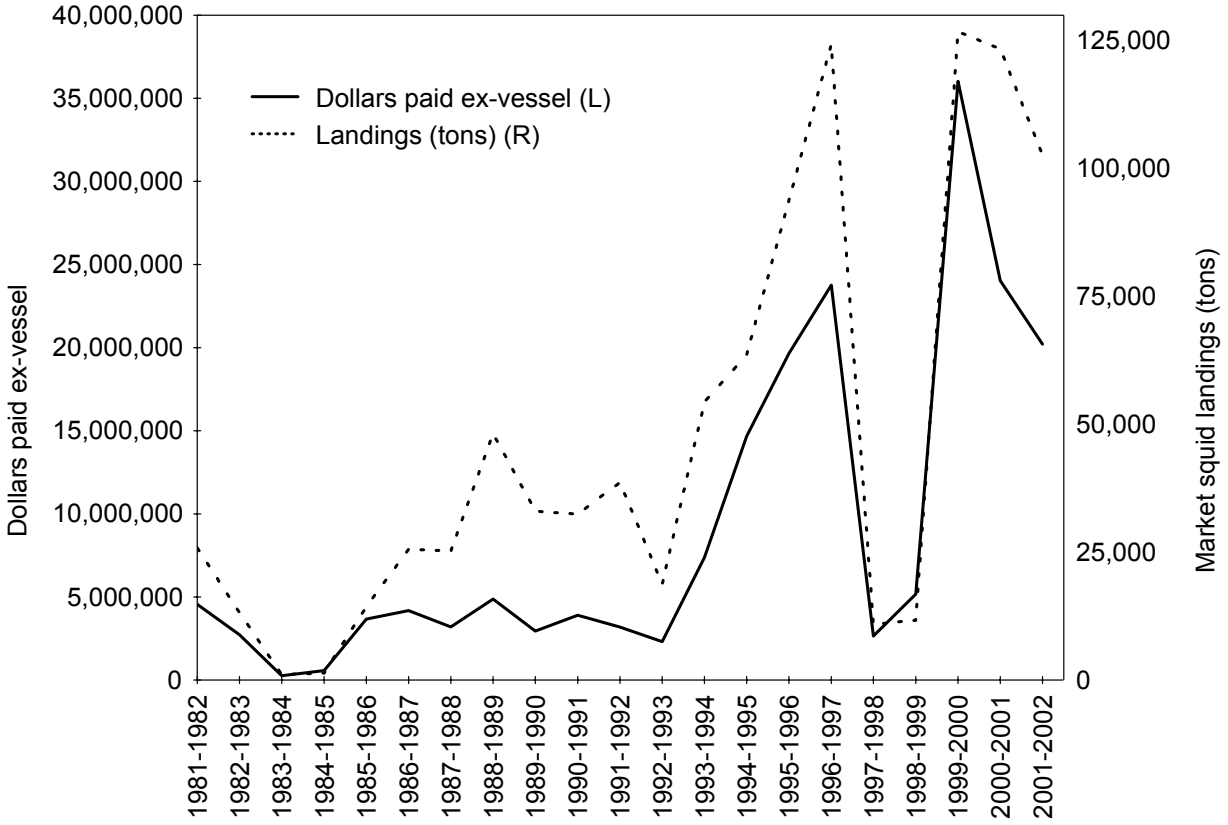

Figure 2-10. Dollars paid ex-vessel and landings in tons for the 1981-1982 through 2001-2002 seasons. Source: CDFG Landing Receipts.

Most of the revenue in the squid fishery is generated by purse seine fishermen (Table 2-10). Drum seine vessels have been increasing their revenues steadily since the 1994-1995 season (excluding El Niño periods). Revenue from squid fishing using lampara nets has declined 99% from 2.7 million dollars in 1981-1982 to very low values in recent years.

Table 2-10. Dollars paid ex-vessel by gear type for market squid fishery from 1981-1982 to 2002-2003 seasons. Note: dollars are not adjusted for inflation. Source: CDFG Landing Receipts.

Season	Brail	Purse seine	Drum seine	Lampara	Other	Total Value
1981-82	$784,085	$485,689		$2,736,398	$544,990	$4,551,162
1982-83	$220,933	$232,256		$2,256,622	$17,260	$2,727,070
1983-84	$9,884	$1,973		$88,548	$168,499	$268,905
1984-85	$313,559	$26,941		$37,497	$192,358	$570,355
1985-86	$22,772	$1,836,397		$755,088	$1,059,659	$3,673,915
1986-87	$46,771	$2,208,225		$819,332	$1,109,205	$4,183,532
1987-88	$30,728	$1,831,687		$473,646	$867,786	$3,203,847
1988-89	$25,106	$2,621,290	$10,924	$956,279	$1,262,613	$4,876,212
1989-90	$16,809	$1,792,182	$23,630	$168,002	$953,209	$2,953,832
1990-91	$12,810	$2,576,712		$109,038	$1,199,802	$3,898,362
1991-92	$5,218	$2,243,108	$2,118	$12,063	$924,899	$3,187,407
1992-93	$5,808	$2,080,155		$22,029	$208,549	$2,316,541
1993-94	$68,758	$6,611,752	$441,568	$1,811	$251,916	$7,375,804
1994-95	$280,832	$8,181,704	$5,857,551	$9,658	$338,642	$14,668,386
1995-96	$213,986	$12,327,482	$6,912,266	$45,053	$146,942	$19,645,729

Table 2-10. Dollars paid ex-vessel by gear type for market squid fishery from 1981-1982 to 2002-2003 seasons. Note: dollars are not adjusted for inflation. Source: CDFG Landing Receipts.

Season	Brail	Purse seine	Drum seine	Lampara	Other	Total Value
1996-97	$109,399	$16,506,397	$6,901,917	$28,358	$211,777	$23,757,850
1997-98	$17,566	$1,752,117	$870,181		$9,137	$2,649,001
1998-99	$97,272	$2,483,404	$1,138,391		$725	$3,719,794
1999-00	$260,915	$27,750,936	$8,009,106	$37,693	$26,235	$36,084,885
2000-01	$437,870	$18,146,102	$5,502,793	$17,042	$54,960	$24,158,768
2001-02	$146,345	$11,601,275	$1,691,986	$2,894	$6,040	$13,448,542
2002-03	$33,392.	$8,369,379	$3,651,143	$119	$3,233	$12,057,268

An average of 114 fishing vessels participate seasonally in the market squid fishery. For the entire squid fishery, the average crew size is 4.5 people (range 3-8, n = 33, Pomeroy et al. 2002). The average purse seine vessel in San Pedro has a crew size of 7.2 (range 4-10). Crew wages are typically 50% of ex-vessel revenue after operating costs. Light boats are paid 20% of the catch value after costs (Lutz and Pendleton 2001). Usually, there is a 1:1 ratio of light boats to seiners on the fishing grounds (A. Henry, pers. obs., O. Amoroso, pers. comm.).

Table 2-11. Percent of revenue received by port area complex from 1981-1982 through 2001-2002 fishing seasons. Note: dollars were not adjusted for inflation. Source: CDFG Landing Receipts.

Season	Monterey Area	Santa Barbara/Ventura	Los Angeles	Other Areas
1981-1982	71.8	4.5	23.7	0.0
1982-1983	84.1	0.1	15.8	0.0
1983-1984	62.7	3.2	3.3	30.8
1984-1985	32.1	21.5	43.9	2.6
1985-1986	42.9	22.3	34.8	0.0
1986-1987	30.5	21.2	46.0	2.2
1987-1988	31.1	34.2	34.2	0.4
1988-1989	23.5	7.3	67.6	1.6
1989-1990	38.9	6.4	54.6	0.1
1990-1991	33.3	31.4	34.5	0.8
1991-1992	27.4	26.0	35.7	10.8
1992-1993	28.2	33.0	19.2	19.7
1993-1994	13.7	35.4	39.6	11.2
1994-1995	19.1	55.6	17.8	7.5
1995-1996	2.2	68.4	28.2	1.2
1996-1997	2.2	62.3	35.2	0.3
1997-1998	80.7	16.2	0.7	2.4
1998-1999	0.0	83.1	16.6	0.3
1999-2000	0.2	68.9	30.8	0.0
2000-2001	7.7	48.1	44.1	0.1
2001-2002	13.2	35.5	50.7	0.7
2002-2003	54.1	33.7	9.7	2.4

From 1981-1982 through 2000-2001, an average of 54 dealers received market squid from fishing vessels each season. In the early 1980s, dealers in the Monterey port area received the majority of the squid business (Table 2-11). This trend has shifted south to the Santa Barbara/Ventura port area complex that has received, on average, 55% of market squid business in the last five years.

2.3.1 Demographic and Social Communities Associated with the Market Squid Fishery

The market squid fishery consists of two major geographical regions: the northern and southern fisheries (Figure 2-11). The northern fishery occurs along the central coast of California centered on Monterey Bay; the southern fishery extends from the Channel Islands southward along the coast to La Jolla. Monterey, Santa Barbara, Ventura and Los Angeles Counties are the principle counties where squid is offloaded. Three primary squid fleets are recognized as distinct groups operating out of these areas: 1) Monterey and Moss Landing (northern fishery); 2) Ventura and Port Hueneme (Ventura and Santa Barbara Counties); and 3) San Pedro and Terminal Island [Los Angeles County, (Pomeroy and FitzSimmons 2001)].

2.3.1.1 Northern Fishery

2.3.1.1.1 Monterey County

In 1997, the Monterey County population was approximately 365,000 with 33,000 people in the city. The city encompasses 8.62 square miles. Monterey County has three main economic focuses: agriculture, tourism, and the military. Agriculture takes place mainly in the Salinas Valley, the stronghold of the Monterey County economy. In 1995, 30% of the county's labor and proprietor income was from agriculture. Tourism activity is concentrated primarily along the coastal areas. The military has the Naval Postgraduate School and the Defense Language Institute, which are located in the city of Monterey. In 1993, military downsizing began with the relocation of 13,000 soldiers and their families from Fort Ord in Monterey County. Currently, the community is working to replace the military industrial sector with an education sector (PFMC 2002). Another valuable economic component of Monterey County began in 1930 with the onset of a thriving fishing industry at Cannery Row. Today, all that remains of this industry is a small commercial fleet and a few fish businesses that operate out of Monterey Bay marinas.

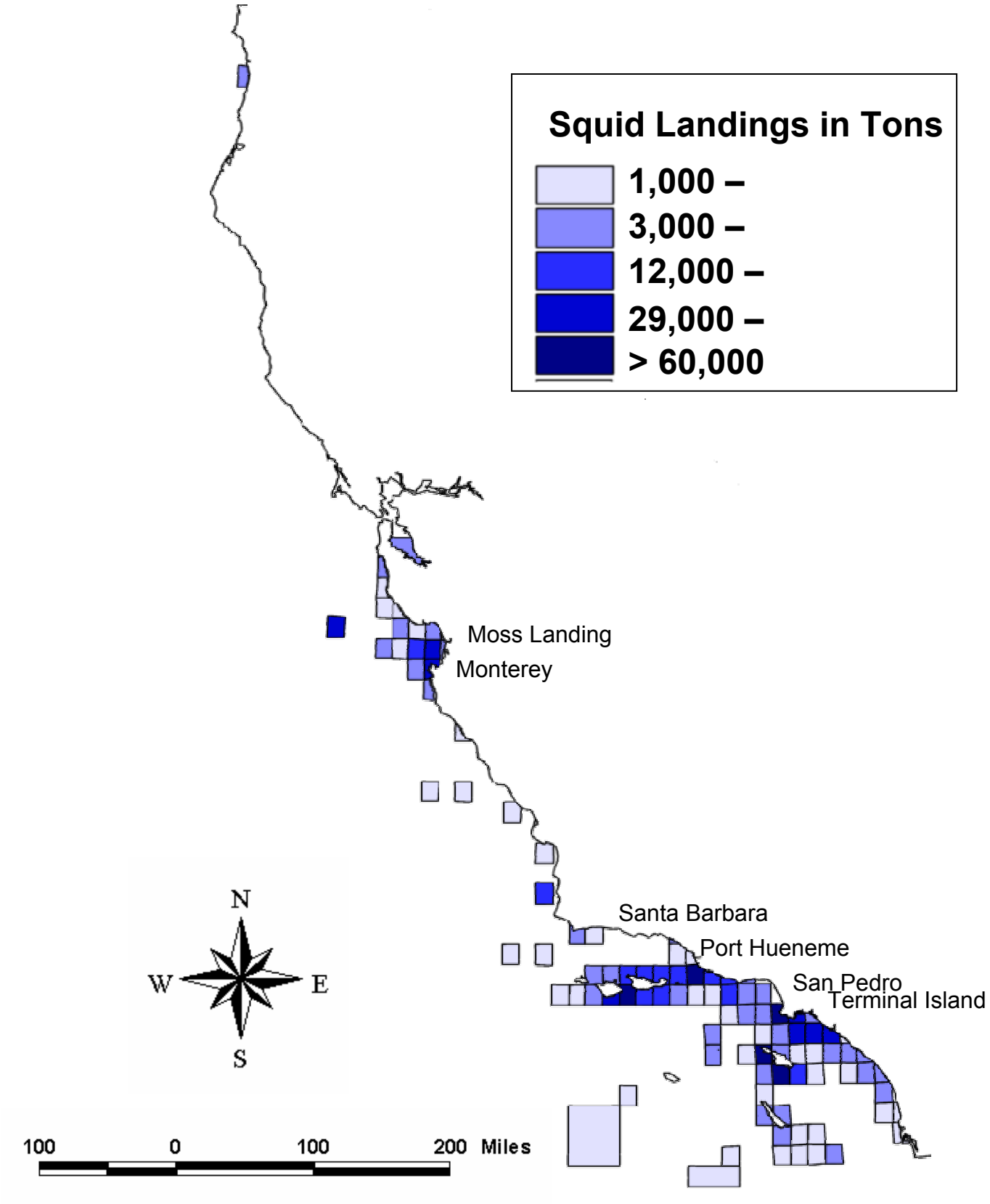

Figure 2-11. Geographic location of major fishing areas in California by CDFG blocks (10' x 10') from 1991 through 2000 based on Department landing receipts.

2.3.1.1.2 Monterey Area Squid Fishery

Monterey Harbor and Moss Landing are the two ports in Monterey Bay that receive market squid. Monterey Harbor has been involved in the squid industry since the late 1800s. Today, space for fish packing and storage facilities at this harbor are limited, so the commercial wharf is used primarily for offloading purposes and squid are transported to processing facilities outside the city. Moss Landing Harbor did not become an active offloading site until 1947. Since then, it has been the site of squid and CPS finfish offloading operations, marine research, recreational fishing and tourism. These industries must share harbor space and sometimes tension exists between the groups (Pomeroy et al. 2002).

Currently, four major processors operate in Monterey Bay and each has historical family links to fishing in the region (Pomeroy et al. 2002). In addition, many current fishermen are descendants of Italian fishermen who settled here long ago and initiated early fishing efforts (Pomeroy and FitzSimmons 2001). Over time, many different vessels have landed squid in Monterey Bay; but the majority of landings are made by a small group of local fishermen collectively known as the Monterey Bay wetfish fleet (wetfish: sardine, anchovy, mackerel, squid and bonito). This subgroup of skippers has extensive social and cultural ties to the wetfish industry and the local community. Historically, the Monterey fleet has fished for a combination of CPS finfish and squid. Many have shifted to other fisheries such as San Francisco Bay herring or Alaska salmon to supplement their income, especially when wetfish catches are low (Pomeroy et al. 2002).

Today, the Monterey Bay fleet consists mostly of modern vessels and drum seines that tend to be larger with steel hulls and often two holds (Lutz and Pendleton 2000). Market squid is one of the primary targets of the Monterey Bay wetfish industry. However, following the El Niño in late 1997, squid landings were slow to recover in this region (Pomeroy et al. 2002) until February 2002.

2.3.1.2 Southern Fishery - Ventura and Port Hueneme

2.3.1.2.1 Santa Barbara County

The population of Santa Barbara County increased from 369,608 in 1990 to 399,347 in 2000 (CTTCA 2000). Agriculture accounted for 11% of Santa Barbara's total income in 1997. In 1999, manufacturing overtook agriculture as the most important contributor to the economy of Santa Barbara County. Non-agricultural income from health care and social assistance, retail trade, professional, scientific and technical services, and construction followed manufacturing in terms of importance (PFMC 2002).

2.3.1.2.2 Ventura County

Similar to Santa Barbara, agriculture accounted for 9% of the county's labor and proprietor income, but was overtaken by manufacturing in 1999. Again, manufacturing

was followed by other sources of non-agricultural income: retail trade, wholesale trade, health care and social assistance, and finance and insurance sectors (PFMC 2002).

2.3.1.2.3 Ventura/ Port Hueneme Fishery

Four harbors play a role in the CPS industry: Santa Barbara, the Channel Islands Harbor, Ventura, and Port Hueneme. Santa Barbara's port is primarily geared towards coastal tourism and only minimal quantities of squid are landed here annually. Similarly, the Channel Islands Harbor is designed mainly to support recreation and does not support commercial fisheries. However, there are holding facilities containing live squid, anchovy, and sardine to provide bait for recreational and commercial fishermen in the area.

Ventura Harbor is of crucial importance for offloading squid. The harbor is used primarily for commercial fishing operations, although port space is shared with sport fishing and tourist operations. Ventura's commercial fishermen are largely composed of descendants of Slavic fishermen who arrived in the area long ago. The Ventura fleet targets squid as well as Alaska salmon and San Francisco herring, but CPS species are not often targeted (Pomeroy and FitzSimmons 2001). Concerns are now being raised about the future economic sustainability of the fishery since several areas of squid fishing at the Channel Islands have been designated as state marine reserves (Pomeroy et al. 2002).

Port Hueneme is located in Ventura County and was created to provide an ocean link from the California central coast agricultural community to global markets (PFMC 2002). Port Hueneme is the U.S. port of entry for the central coast area of California and the only deep-water harbor between Los Angeles and San Francisco harbors. It ranks among the top seaports in California for general cargo. Port Hueneme specializes in the import and export of automobiles, heavy agricultural equipment, industrial vehicles, fresh fruit and produce, forest products, and other cargo. Port Hueneme ranks as the top seaport in the United States for citrus export and it ranks among the top ten seaports for automobile and banana imports. Over $4 billion in cargo value moves through Port Hueneme annually. The port provides space for local sport and commercial fishing industries and related activities generate over $388 million for the local economy each year; 3,500 jobs in Ventura County are related to operations at Port Hueneme (PFMC 2002).

Since 1985, Port Hueneme has been the top squid receiving port in the state. The primary function of this deepwater port is cargo transportation. As a result, space allotted for commercial fishing operations is often cramped and crowded (Pomeroy et al. 2002). Historically, Port Hueneme has been an important receiving station for the wetfish industry. The number of processors fluctuates from year to year depending on the market; but, on average, there are eight processors working the region at a given time. In addition, the timing of the squid season complements the community's agricultural off-season providing ample labor, cold storage and transportation resources. There are two distinct groups of fishermen in this fleet. The first group is composed of local in-state fishermen who primarily target CPS finfish, squid, and occasionally tuna

and bonito. Many fishermen in this group are from Monterey and San Pedro/ Terminal Island areas and are drawn to the area in the winter for the squid fishery since revenues are declining in the Alaska salmon fishery and boats are being excluded from the San Francisco Bay herring fishery. The second group, over half of the fleet, are out of state fishermen attracted to the southern California market squid fishery after encountering problems in other fisheries (e.g., salmon, herring). The Ventura ports are utilized by many fishermen working the Channel Islands since they are closer and more convenient than Monterey or San Pedro ports (Pomeroy et al. 2002).

2.3.1.3 Southern Fishery - San Pedro/ Terminal Island

2.3.1.3.1 Los Angeles County

The ports of San Pedro and Terminal Island are located in the county of Los Angeles. The population of Los Angeles County increased from 8,863,000 to 9,519,000 between 1990 and 2000.

2.3.1.3.2 San Pedro

The population in San Pedro decreased from 85,987 in 1990 to 84,697 in 2001. In 1996, 51.6% of the community was Caucasian, 33.8% was Hispanic, 6.2% was African American, and 7.6% was Asian. The average per capita income in 1996 was $19,413 (Claritas 1996).

San Pedro is located in southwest Los Angeles on the southeastern slope of the Palos Verdes Peninsula. The community's roots developed over a century of participation in fishing and related industries and are described in the San Pedro Community Environmental Perspectives (1989). The community is relatively small with a hometown feeling and is enhanced by the fact that many residents are locally employed.

During the 1980s, the commercial fishing industry in Los Angeles declined, directly affecting the local economies of San Pedro and Wilmington. One reason for the decline was competition from foreign fisheries, which operated with lower labor costs and government subsidies. State and local taxes and high insurance costs were blamed as additional burdens on the struggling industry. By 1986, only one fish packing plant remained of the 14 that operated in 1960 (PFMC 1998). This plant has since closed.

2.3.1.3.3 San Pedro/Terminal Island Fishery

The San Pedro/Terminal Island fishery industry is not the primary focus of the ports in this region. The main priority at these ports is tourism and transportation of cargo, oil and gas. However, San Pedro has long been recognized as a major center for the California CPS industry's purse seine fleet. Much of the revenue generated by the fleet remains in the community through slip fees, boat maintenance, fuel purchases, live bait sales, and by supplying squid for processing (Lutz and Pendleton 2001). Many fishery participants have ancestors from Italy and the country formerly known as Yugoslavia that participated in the fishery generations past. Most of the San Pedro fleet relies

solely on market squid, coastal pelagic species (CPS) and coastal tuna for their income. As a result, the variability and uncertainty in the market affect fishermen, processors and receivers. Historically, participants in this fishery have survived by shifting their efforts between species (Pomeroy et al. 2002).

A survey of the San Pedro fleet initiated in 2000 revealed that most of the vessels were old with wooden hulls (Lutz and Pendleton 2000). The average age of the vessels in this fleet is 47 years and, thus, cost effective insurance is not available to over 1/3 of the fleet. Another problem is non-uniform fishing effort within the fleet. In 1999, four vessels landed 45.6% of the total fleet revenue because they were able to operate at higher production levels and thereby dominate the fleet (Lutz and Pendleton 2001). In the mid 1990s, San Pedro ports experienced an incursion of out of state vessels to participate in the market squid fishery. This resulted in a flooded market and caused squid prices to fall (Lutz and Pendleton 2001).

2.3.1.4 Summary of the Three Squid Fishery Areas

In all three regions, most skippers view commercial fishing as a family tradition. In fact, most have other family members involved in fishing, processing, or market activities. The relationship between fishermen and the markets plays a vital role in the survival and sustainability of a fishery. The California market squid fishery began as a small industry that supplied squid to local markets. In recent years, the fishery has shifted away from local markets. Currently, the California squid industry is now centered on global markets that have placed an increased demand upon California market squid. Additionally, squid fishing is driven by market orders. Vessels targeting squid usually have a relationship with one market from which they receive orders for specific amounts of squid. When demand or storage space is limited, boats are placed on limits regardless of squid availability (Pomeroy and FitzSimmons 2001).

2.4 History of Conservation and Management Measures

2.4.1 State Management

The regulatory history of the commercial market squid fishery by the State of California began with a ban on squid attracting lights in 1959 (Table 2-13). The addition of former FGC §8397 in 1957 prohibited the use of these lights in the Monterey Bay fishery. Processors believed that squid caught with the aid of attracting lights were of poorer quality and smaller in size than those caught without lights. The fishermen also felt that the lights disrupted the spawning. Further, banning attracting lights would prevent canneries from harvesting squid directly from their docks. This prohibition was lifted in 1987 for most of Monterey Bay (District 17); in 1988, attracting lights were once again allowed in the Pacific Grove area in Monterey Bay (District 16).

In 1983, the Commission adopted regulations that limited the days of the week and times of day that fishermen could engage in the take of market squid. CCR Title 14 §149 prohibited any vessel, using or possessing a roundhaul net in Monterey, from taking market squid between noon on Friday and midnight on Sunday, and between

noon and midnight on any day Monday through Thursday. In 1989, Senate Bill (SB) 1080 (Mello) allowed fishermen to utilize all types of roundhaul nets, including purse and half-purse seine nets, in the take of market squid in the Pacific Grove area (District 16). In 1990, the Commission amended its regulations (CCR Title 14 §149) to allow for the take of squid by roundhaul gear before midnight Monday through Thursday north of a line running 252º magnetic from the Moss Landing Harbor entrance.

In 1993, the market squid landing tax was increased to $0.0019 per pound (SB 1030, Thompson). The same year, Assembly Bill (AB) 14 (Hauser) restricted vessels from the use of squid attracting lights in District 10 (ocean waters of San Mateo, San Francisco, Marin and Sonoma Counties).

Before April 1998, the market squid fishery was largely an unregulated, open access fishery. Because of increasing market interest and rising squid landings, SB 364 (Sher), was passed in 1997. This legislation established a $2,500 permit for market squid vessels and light boats and a three-year moratorium on entry into the fishery; called for a three-year study of the fishery; and provided for the creation of a Squid Fishery Advisory Committee (SFAC) and a Squid Research Scientific Committee (SRSC) to advise the Department on research and interim measures. Senate Bill 364 also required that the Department present a report on the fishery to the Legislature, with recommendations for a conservation and management plan by April 2001.

In 1998, the MLMA was enacted. In 1999, the Legislature appropriated $5.2 million to implement this legislation. The MLMA removed from the Legislature the burden of micro-managing fisheries by transferring that oversight role to the Commission and directing several actions, including the:

- development of a master plan for implementing the MLMA;
- development of management plans for California state fisheries; and
- development of a plan for dealing with emerging fisheries as they become operational in California.

In 2000, SB 1544 (Sher) was enacted, reducing the market squid permit fee to $400 from $2,500 until April 2003 and extending the sunset date for FGC Article 9.7 to 1 January 2004. When Governor Davis signed this legislation, he did so to ensure uninterrupted protection and regulations for the squid fishery, but requested that the Legislature, squid fishermen and their representatives as well as other stakeholders “review the appropriateness of the squid permit fee.”

In 2000, the Commission adopted interim measures for the market squid fishery under CCR Title 14 §149. The regulations prohibited the commercial take of market squid between noon on Friday and noon on Sunday from Pt. Conception south to the US-Mexico border and required commercial squid vessels and light boats to maintain logbooks detailing fishing/lighting activities. In response to potential negative effects on nesting seabirds of vessels lighting for squid on several of the Channel Islands, the regulations restricted attracting lights to a maximum of 30,000 watts and required that lights be shielded.

In 2001, SB 209 (Sher) was enacted, authorizing the Commission to manage the squid resource and to adopt a market squid fishery management plan. Other features of this bill included providing that specified provisions will become inoperative upon the adoption by the Commission of a market squid fishery management plan and the adoption of implementing regulations and will be repealed 6 months thereafter.

In 2001, the Commission established a harvest guideline of 125,000 tons for the market squid fishery, which was based on the highest seasonal catch level for the fishery; its purpose was to prevent volumetric growth of the fishery should market demand encourage such expansion.

Table 2-13 Summary of Market Squid Regulations from 1959 to the present.

Date	Bill # (Author)	Management Action
1959	§8397	It is unlawful to use any artificial light to lure or attract squid in Districts 16 and 17. This section applies to all artificial lights except those lights necessary for the usual operation of a vessel not used to lure or attract, or intended to lure or attract, squid.
1983	AB 513 (Farr)	Authorizes the Commission to adopt regulations specifying the days of the week and times of the day when squid may be taken north of Point Conception.
1984	CCR Title 14 §149	The Commission adds CCR Title 14 §149, to prohibit any vessel, using or possessing a roundhaul net in Districts 16 and 17, from taking market squid between noon Friday and midnight Sunday and between noon and midnight on any Monday through Thursday.
1987	AB 123 (Farr)	Allows the use of lights to attract squid in District 17.
1988	AB 4055 (Farr)	Allows the use of lights to attract squid in District 16.
1989	SB 1080 (Mello)	Allows the use of all roundhaul nets, including purse seine and half-purse seine nets, to take squid in all portions (including the southernmost portion) of District 16, subject to the same area and season restrictions previously in effect for lampara nets.
1993	AB 14 (Hauser)	Restricts the use of attracting lights in District 10.
1993	SB 1030 (Thompson)	A landing tax of $0.0019/lb is imposed.
1997	SB 364 (Sher)	Authorizes the take of market squid north of Pt. Conception between noon on Sunday and noon on Friday. Requires a permit for the take of squid with a dip, purse seine, or lampara net for commercial purposes. Requires a permit to attract squid by light from a vessel. Establishes a fee for a commercial squid light boat owner's permit. Allows for transfer of vessel or light boat owner's permits under certain conditions. A three-year moratorium on commercial squid vessel permits is established; the possession of a permit from the previous year is required in order to renew.
1998	AB 1928 (Morrow)	No permit is necessary, nor is a landing tax imposed, for the take of live bait. Drum seines and other roundhaul nets excepted from prohibition of rings along lead line and pursing of net bottoms.
1998	AB 1241 (Keeley)	Marine Life Management Act passes.
2000	CCR Title 14 §149	Amendment – Prohibits commercial take of market squid between noon on Friday and noon on Sunday from Pt. Conception south to the US-Mexico border. Requires commercial squid vessels and light boats to maintain logbooks detailing fishing/lighting activities.

Table 2-13 Summary of Market Squid Regulations from 1959 to the present.

Date	Bill # (Author)	Management Action
2000	CCR Title 14 §149	Amendment – Vessels fishing or lighting for squid are restricted to using no more than 30,000 watts of light. Each vessel fishing or lighting for squid must shield the entire filament of each light, directing the light downward, or the vessel must keep the illumination completely submerged underwater.
2000	SB 1544 (Sher)	Establishes a $400 fee for a commercial market squid vessel permit. Extends the sunset date for SB364 to 1 January 2004. Extends existing duties imposed on the Department and the Commission and makes an appropriation.
2001	SB 209 (Sher)	Requires the Commission to adopt the MSFMP by 31 Dec 2002, after consideration and public hearings. Requires the Commission to establish fees for commercial market squid vessel permits and commercial squid light boat owner's permits annually commencing April 1, 2003. Prohibits each person who is issued a commercial squid light boat owner's permit from selling, trading or transferring the permit to another person. Provides that specified provisions will become inoperative upon the adoption by the Commission of a MSFMP and the adoption of implementing regulations and will be repealed 6 months thereafter.
2001	CCR Title 14 §149	Proposed regulatory changes establish catch limits in order to protect the squid resource and manage the fishery sustainably; a harvest guideline of 125,000 tons was selected.

2.4.2 Federal Management: Coast Pelagic Species Fishery Management Plan (CPS FMP)

Amendment 8 of the CPS FMP placed Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*) in a management unit with northern anchovy (*Engraulis mordax*). Managed species are divided into two categories: "Actively managed" and "monitored". Actively managed species are subject to annual harvest limits based on current biomass estimates. There are no mandatory harvest limits for monitored species; however, other management measures, such as area closures, could apply to monitored species. Initially, Pacific sardine and Pacific mackerel are designated as actively managed species, while jack mackerel, northern anchovy, and market squid are monitored species. However, the CPS FMP required that Maximum Sustainable Yield (MSY) be established for all species in the plan. Setting MSY for market squid is problematic because a biomass estimate has yet to be determined. A proxy for MSY, using egg escapement, has been approved for the market squid fishery. Details of this method are presented in section 3.2. Finally, the PFMC delegated management authority for market squid to the State.